DESIGN OF A GROUP DECISION SUPPORT SYSTEM FOR PRIORITIZING AIR FORCE LOGISTICS NEEDS

THESIS

Richard M. Schooff
Captain, USAF

AFIT/GOR/ENS/90M-16

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/GOR/ENS/90M-16

DESIGN OF A GROUP DECISION SUPPORT SYSTEM FOR PRIORITIZING AIR FORCE LOGISTICS NEEDS

THESIS

Richard M. Schooff
Captain, USAF

AFIT/GOR/ENS/90M-16

AFIT/GOR/ENS/90M-16

DESIGN OF A
GROUP DECISION SUPPORT SYSTEM
FOR
PRIORITIZING AIR FORCE LOGISTICS NEEDS

THESIS

Presented to the Faculty of the School of Engineering

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Operations Research

Richard M. Schooff, B.S.

Captain, USAF

March 1990

Approved for public release; distribution unlimited

Preface

A primary goal of an Operations Research analyst is that of assisting decision makers to make better decisions. I am convinced that this goal will never fully be met until we move our analytical models out of the "analyst's world" and into that of the decision maker. Decision Support Systems provide a vehicle for accomplishing this purpose.

I am indebted to several individuals for their assistance in this research. I want to thank my advisor, LtCol Skip Valusek, for his expertise, guidance, and encouragement. His enthusiasm for this research provided needed "battery charges" when mine ran low. Thanks also go to all those who responded to the surveys, endured concept mapping sessions, and otherwise provided their insight and expertise.

Most importantly, I need to thank my wife, Sharon, and daughter Ashley, for their patience and personal sacrifice throughout our AFIT experience. Without their support and love this research could never have been completed: it was truly a team effort.

Table of Contents

List of Figures

List of Tables

Abstract

Annually, the Air Force Office for Logistics Technology Applications (AFOLTA) is responsible for developing a prioritized list of the Air Force Logistics Needs (LNs) to aid military and industry decision makers who allocate funds for logistics research and development programs. To develop this list, AFOLTA convenes a conference with representatives from the Air Force Major Commands who, as a group, prioritize the LNs. The decision task is characterized by its complexity, having a great amount of uncertainty, yet being extremely important to increasing Air Force operational capability.

This ~~research~~ focused on the decision process involved in prioritizing LNs and on the design of a group decision support system (GDSS) to aid the decision process. The requirements of such a GDSS were assessed. The functions, processes, models, and data required for prioritizing LNs were identified and incorporated into the design of the GDSS.

The kernel design of the GDSS was a management information system to support the information requirements of a multi-attribute decision making model.

A roadmap plan was prepared for transitioning from the current process to implementing the designed GDSS.

DESIGN OF A
GROUP DECISION SUPPORT SYSTEM
FOR
PRIORITIZING AIR FORCE LOGISTICS NEEDS

I. Introduction

Annually, the Air Force Office for Logistics Technology Applications (AFOLTA) is responsible for developing a prioritized list of the Air Force Logistics Needs (LNs) to aid military and industry decision makers who allocate funds for research and development programs. To develop this list, AFOLTA convenes a conference with representatives from the Air Force Major Commands (MAJCOMs) who, as a group, prioritize the LNs. Since the prioritized list is so important, AFOLTA is interested in evaluating its decision making process.

Specific Problem Statement

AFOLTA has not yet evaluated the process by which its prioritized list of LNs is developed. The purpose of this research was to analyze AFOLTA's group decision making process that generates a prioritized list of Air Force

Logistics Needs and apply the concepts of Group Decision Support Systems to the prioritization problem.

Scope of the Research

This research focused on the decision process involved in prioritizing LNs and on the design of a group decision support system (GDSS) to aid that decision process. The GDSS for prioritizing LNs was designed by identifying necessary functions, processes, models, and data. The designed GDSS is ready for a systems analyst or software engineer to evaluate and build an operational GDSS.

Application to the Reader (Motivation to Read)

This research may be of benefit to the Air Force or industry manager whose work relates to logistics and to managers who face complex decision problems. Managers who are concerned with logistics issues will want to examine the criteria identified as being important in determining the value of a given logistics need. These criteria defined the important characteristics of logistic issues. The investigation of logistics research and development information and the logistics requirements information -- its sources and availability -- will also assist logistics managers.

Additionally, managers facing complex decision problems and those looking to implement a decision support system can

also be assisted by this thesis. First, ideas on decision making and multiple attribute decision making are presented. This knowledge helps a manager structure and organize the problem at hand. Second, methods of solving such a problem are discussed. These give a manager some tools to apply to his specific problem. Third, the use of decision support systems is described. A roadmap structure to aid in transitioning from current, manual methods to a robust decision support system is presented. This roadmap could be applied to a wide variety of decision problems where improvement could be made through implementing a decision support system.

Sub-Objectives of the Research

1. Describe the Current Process.

A. Describe the flow and control of information in the LN process.

B. Describe the current prioritization method and procedures of the MAJCOM Coordination ("Rack-and-Stack") conference.

2. Evaluate Effectiveness of Current Methods

A. Identify shortfalls between AFOLTA's current process and what the theory shows as being necessary for that process.

B. Define desired qualifications for group participants.

C. Determine LN information requirements and availability.

D. Define specific criteria for LN prioritization.

3. Apply Group Decision Support System Concepts

A. Define AFOLTA's needs and priorities for the processes and functions which a GDSS could support.

B. Identify methodologies which would be a part of an LN prioritization GDSS.

C. Design a kernel system for prioritizing LNs.

D. Prepare a roadmap for implementing a GDSS.

Background

Logistics Need. An Air Force Logistics Need (LN) is a formal Air Force logistics technology requirement which can be resolved with advancements in technology or application of existing technology (AF Reg 80-33, 1989:1). Logistics refers to the aspect of military science of planning and carrying-out the movement and maintenance of forces. The Air Force officially states:

> In its most comprehensive sense, logistics pertains to those aspects of military operations which deal with (a) design and development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposition of materiel; (b) movement, evacuation, and hospitalization of personnel; (c) acquisition or construction, maintenance, operation, disposition of facilities; and (d) acquisition or furnishing of services. (AFIT, 1980:401)

Thus an LN could result from any of these logistic support functions of the Air Force.

LNs are not solutions to a requirement, but are simply the statement of that requirement. The technology necessary to solve an LN may or may not currently exist. Additionally, there may be several different approaches to solve a given LN. Given the diversity of the LNs and the uncertainty of a technological solution coupled with the need to achieve a consensus across the MAJCOMs, the prioritization effort is no simple matter.

Logistics Need Program. There are three primary purposes of the Air Force Logistics Needs Program. First is to identify Air Force logistics research and development requirements (AF Reg 80-33, 1989:1). The identified Logistics Needs serve as a catalyst for the second purpose, influencing Air Force and industry research and development (R&D) programs to conduct logistics-related technology development (AFOLTA, 1989). Third, the LN Program encourages the application of mature technologies to enhance the capability of new and existing weapon systems (AFR 80-33, 1989:1)

Logistics Needs Identification. Annually, the Headquarters of the Air Force Directorate for Logistics and Engineering (HQ USAF/LE) initiates the LN identification process with a call to the field for LNs. Figure 1 depicts the LN identification process. LNs can be identified at several levels, from the Air Staff level, to the MAJCOM level, down to an operational unit level (Nenninger, 1989).

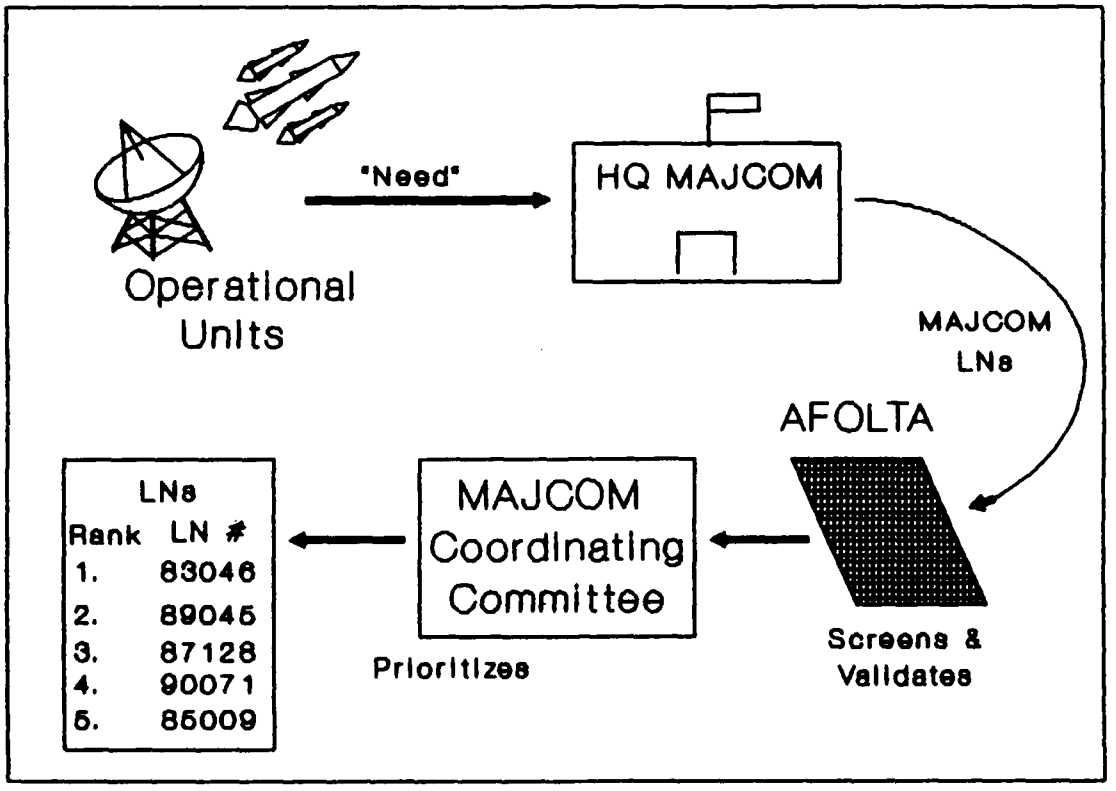


Fig. 1. The LN Identification Process (adapted from AFOLTA, 1989)

Many LNs are initially identified at the most fundamental operating levels of the Air Force: the front-line maintenance personnel, technicians, and operators. With their first-hand experience in the day-to-day operations, these experts identify deficiencies which an application of technology could correct. These requirements are then formalized by the governing MAJCOM.

After collecting LNs from their various organizations, each MAJCOM submits its list of LNs to AFOLTA. AFOLTA thoroughly reviews the LNs and validates and categorizes them. The LNs are categorized as one of three types of LN based on the state of technology required to solve the need. A Logistics Research Need (LRN) is a requirement for a laboratory technology research effort. Logistics Development Needs (LDN) are requirements for "operational prototyping and engineering development using state-of-the art technology" (AF Reg 80-33, 1989:3). A Logistics Application Need (LAN) is a requirement which can be fulfilled by acquiring and applying existing technology.

A MAJCOM Coordinating Committee consisting of representatives from each participating MAJCOM meets to prioritize over 200 LNs. Having only a one-page written description of each LN, the committee prioritizes the LNs and reaches a consensus through an iterative balloting and discussion process. The prioritized list of LNs is reviewed and approved by a general-officer review panel before being sent to USAF/LE for final approval.

Influencing Air Force and Industry R&D. The final, approved list of LNs is published as the Air Force Logistics Research and Studies Program (see Figure 2), commonly referred to as the "Brown Book" (AFOLTA, 1989).

The Brown Book is distributed to Air Force laboratories and research organizations and to numerous industry R&D

operations. These R&D organizations use the Brown Book in planning their research agenda and budget, placing emphasis on the technologies which would meet the known needs of the Air Force (and mean potential profits to the company) (Nenninger, 1989).

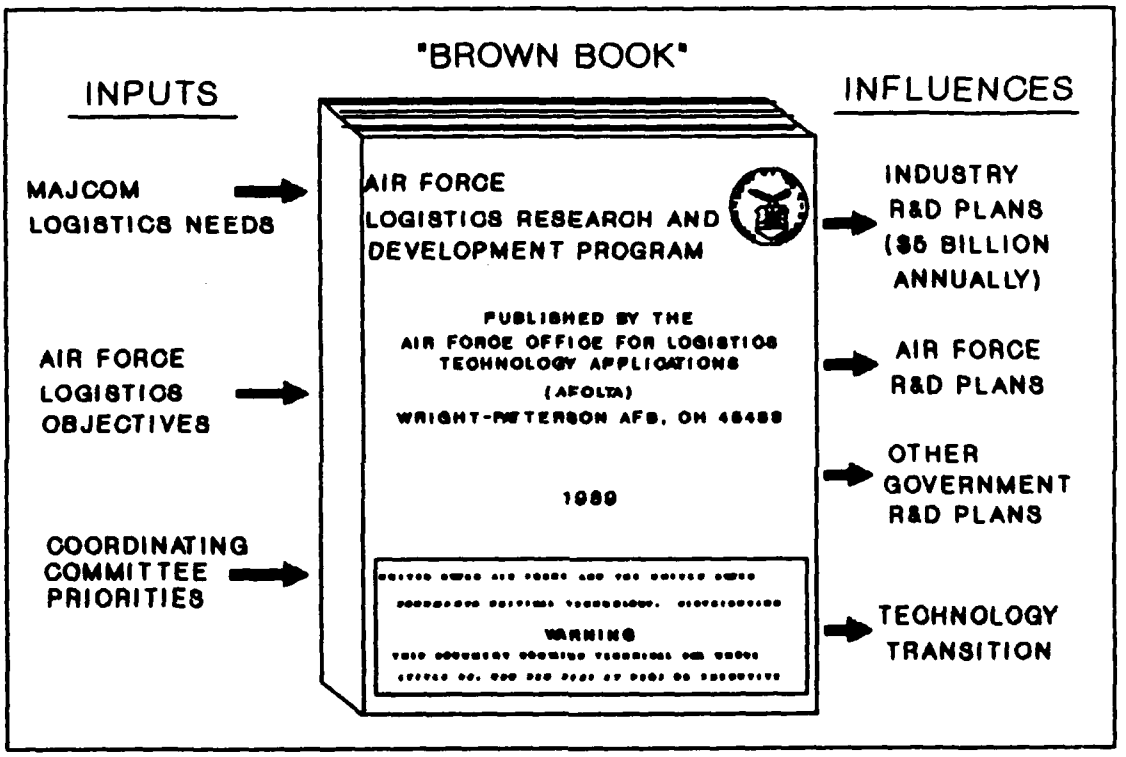


Fig. 2. LNs Influence Research and Development Efforts (adapted from AFOLTA, 1989)

Although no funds are directly associated with the prioritized list of LNs, their ranking does impact the distribution of the approximately $5 billion spent annually by leading industries for research and development efforts (AFOLTA, 1989). An LN's ranking particularly affects the

potential for research being conducted to meet that particular need.

Application of Technology. The LN Program also functions as a "matchmaker" between technology developers and technology consumers (AFOLTA, 1989). Figure 3 shows that AFOLTA plays a major role in matching Air Force technology consumers with government and industry technology developers.

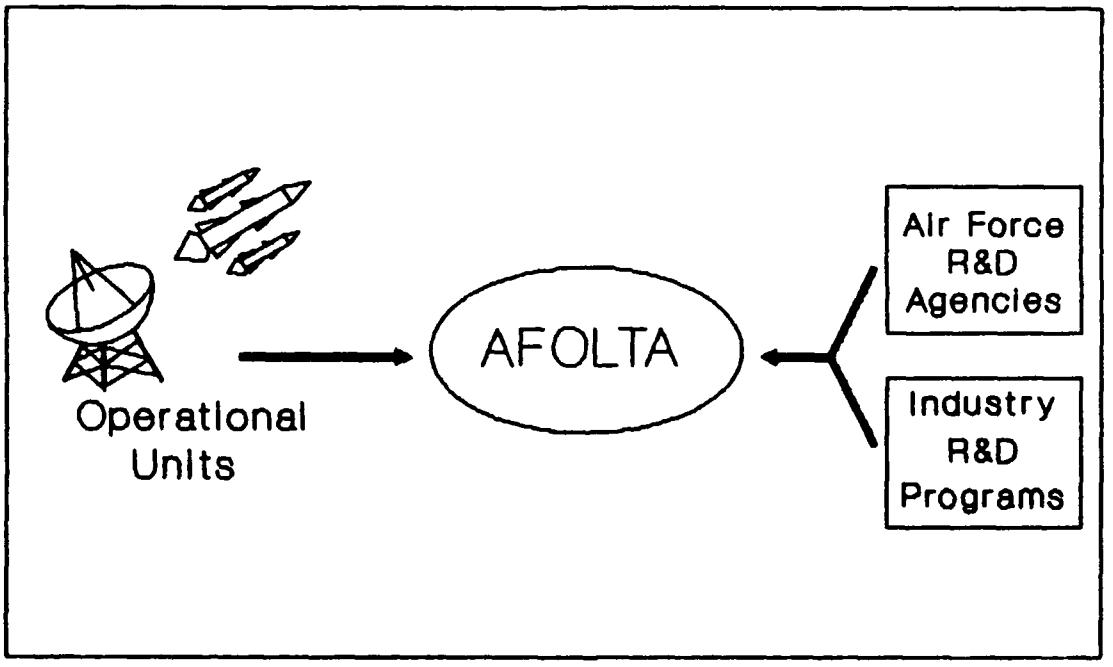


Fig. 3. LN Program is a "Matchmaker" Between Technology Consumers and Developers

Quite often a MAJCOM submits a LN to AFOLTA unaware that technology already exists which could solve the need. Through the LN Program, AFOLTA serves as a knowledgeable source for technology developments. Frequent contact with

technology developers in government and industry laboratories, along with constant knowledge of Air Force needs permits AFOLTA to connect the sponsoring MAJCOM with the organization that has the technology to solve the particular requirement.

Summary

The Logistics Need Program exists to identify and meet Air Force logistics technology requirements. Prioritizing the LNs helps focus government and industry research efforts on those technologies most important to the Air Force. The diversity of the LNs and the uncertainty of a technological solution coupled with the need to achieve a consensus across the MAJCOMs complicate the LN prioritization effort. Table I summarizes the problems which characterize the LN prioritization effort. An analysis of the LN prioritization process, information requirements, and the application of a group decision support system could improve the prioritization process.

Before such a analysis could be conducted, however, it was necessary to first examine the theory and methods relevant to prioritizing LNs. This is the topic of the next chapter.

Table I. Description of the LN Prioritization Environment

Characteristic	Description
Complexity	- Over 250 LNs to prioritize - Competing MAJCOM goals - Wide range of technologies - Multiple decision makers - Substantial time commitment
Complex Preferences	- MAJCOM preferences vary - Decision maker preferences vary - Undefined evaluation criteria
Uncertainty	- Lack of relevant information - Technology unknowns - Unknown impact on operations
Importance	- Impacts combat capability - Influences R&D resources

II. Applicable Theory and Methods

Overview

A decision problem such as AFOLTA's involves the understanding of several areas of decision theory. This section will review theory and methods relevant to AFOLTA's problem. The areas of decisions, decision making, and multi-criteria decision making, in addition to group decision making and group decision support systems will be addressed.

Decisions

In its broadest sense, a decision is "... an irrevocable allocation of resources" (Tatman, 1989). In their personal and professional lives, individuals are constantly facing the task of making decisions. The resources expended in making and implementing the decisions are as varied as the decisions themselves. These resources could be an individual's time, a corporation's financial assets, or an Army's combative forces. In AFOLTA's case, the prioritization decision involves a great expense of time and energy resources of the MAJCOMs and their representatives. Additionally, the vitality of key operations -- the Air Force's most important resource -- depends on the solution of these needs. Distribution of the R&D resources which are used to research solutions to the LNs is influenced by the prioritization decision.

Dr. Ron Howard, a founder in the study of modern decision analysis, characterizes the decisions facing top management by the following:

> Uniqueness. Each is one of a kind, perhaps similar to -- but never identical with -- previous situations.
> Importance. A significant portion of the organization's resources is in question.
> Uncertainty. Many of the key factors that must be taken into account are imperfectly known.
> Long run implications. The enterprise will be forced to live with the results of the situation for many years, perhaps even beyond the lifetimes of all individuals involved.
> Complex preferences. The task of incorporating the decision maker's preferences about time and risk assume great importance. (Howard, 1983:22)

AFOLTA's prioritization problem contains Howard's characteristics. Although an annual problem, it is similar to, but never identical with, the previous year's problem. The importance of the decision is beyond question in that the LNs represent the operational needs of the Air Force. Solving these needs would improve the combat capability of the forces. There is a great deal of uncertainty in prioritizing LNs, particularly relating to the unknowns associated with technology development. This uncertainty is compounded by pertinent information not being available to the decision makers. The long-run implications of the prioritization are the direction and scope of R&D efforts and their impact on combat capability. For the MAJCOMs, each with its own agenda of issues and priorities, arriving at an agreeable prioritized list requires the combining and compromising of their complex preferences.

In addition to Howard's characteristics of decisions, Nobel Prize recipient Herbert A. Simon proposes that decisions can be categorized as being either programmed or nonprogrammed (Simon, 1965:58). Programmed decisions are those that are "... repetitive and routine, to the extent that a definite procedure has been worked out for handling them" (Simon, 1965:58). Conversely, nonprogrammed decisions are:

> ... novel, unstructured, and consequential. There is no cut-and-dried method for handling the problem because it hasn't arisen before, or because its precise nature and structure are elusive or complex, or because it is so important that it deserves a custom-tailored treatment. (Simon, 1965:59)

These categories of decisions are also referred to as structured and unstructured decisions (Sprague, 1982:94-95). Additionally, Sprague refers to an in-between class of problems: semi-structured decisions. These decisions may have characteristics of both structured and unstructured decision problems. AFOLTA's task of prioritizing a list of diverse LNs is semi-structured decision problem. It is truly complex, not having a formatted methodology to its solution. On the other hand, the prioritization problem is an annual, recurring decision problem and thus some sort of procedure or methodology could be applicable to the decision process.

Decision Making

Decision making is the force that directs the course of

individuals, organizations, and even society. Decision making can be defined as the

> ... work of choosing issues that require attention, setting goals, finding or designing suitable courses of action, and evaluating and choosing among alternative actions. (Simon, 1987:11)

Phases of Decision Making. Simon states that regardless the nature of the decision -- structured or unstructured -- the decision making process has to progress through three critical phases:

> The first phase of the decision making process -- searching the environment for conditions calling for decision -- I shall call intelligence activity (borrowing the military meaning of intelligence). The second phase -- inventing, developing, and analyzing possible courses of action -- I shall call design activity. The third phase -- selecting a particular course of action from those available -- I shall call choice activity. (Simon, 1965:54)

Intelligence. The first phase, intelligence, is the gathering of data required by decision makers in order to make a decision. This data may come from electronic databases, personal interviews, or through other activities or sources appropriate to the decision. Ackoff (1967:B-148) warns of the need for information filtering during this phase to ensure that gathered data is relevant to the decision. Additionally, different types of decisions have different information requirements. "Strategic planning decisions tend to require more varied, more aggregate, and more qualitative data than do management control decisions" (Sprague, 1982:97). A structured decision has different requirements than an unstructured one. In addition to

simply gathering relevant information, this phase also seeks to apply understanding and interpretation to the collected data.

Design. The design phase involves the creation of the methodology for making the decision (Nettleton, 1987:12). Nettleton also notes that it is in this stage that the criteria which influence the final decision are selected. The nature of the decision, its complexity, whether it is programmed or nonprogrammed, the information available, and the expertise of the decision maker contribute to methodology formulation.

Choice. "In the final phase, choice, the decision maker focuses his energy on selecting the particular course of action from those available" (Nettleton, 1987:12). The goal of this phase is to identify the "best" alternative from all possible alternatives. Sprague (1982:97) indicates that the objective used to chose an alternative may be selected from a wide range of possibilities. These objectives could range from a rigorous search for the maximum expected value of a decision, to simply finding the first cost-effective alternative based upon some heuristic rather than optimal search technique.

Quite often, the best alternative is not the one selected. Simon (1987:18) observes that many people "... appear to satisfice rather than attempting to optimize." They choose a "good enough" alternative rather than working to find the optimal alternative.

Processes of Decision Making. Although all decision making processes progress through Simon's three phases, there is a wide variety in the processes. The processes for programmed decision making are more easily studied, due to the patterned, routine nature of the decisions (Adizes, 1985:46). Structured decisions tend to be better adapted for using calculations and defined algorithms. Traditional operations research and mathematical analysis models have greatly eased the process of making structured decisions (Nettleton, 1987:10). Adizes (1985:45-49) outlined the basic process of making structured decisions as containing the following steps: 1) putting ideas in writing, 2) discussing the ideas, and 3) ranking and discussing priorities. Other researchers (Rivchun, 1985:24; Cook, 1987:31) described similar processes for structured decision making and expanded on Adizes' steps by adding two more: understanding the problem, and identifying relevant criteria and alternatives.

Unfortunately, managers and upper-level decision makers rarely get the opportunity to wrestle with the straightforward, structured problems. They are most often faced

with complex, unstructured decision problems (Howard, 1983:22). Sprague (1982:95) states that it is the nonprogrammed, unstructured decisions which are of greatest concern to decision makers. He further states that the process of making nonprogrammed decisions varies depending on the nature, complexity, and scope of the problem, the decision maker, and the uncertainties inherent to the decision.

Concept Maps. As a tool for understanding a specific decision making process, Valusek (1988:107) emphasizes the value of concept maps. A concept map is a decision making diagram used to communicate ideas, relationships, and functions of a decision process (McFarren, 1987:1-2). The map is a "spider web" network of thoughts and concepts linked by their relational characteristics. McFarren states that a concept map helps describe understanding of the problem, helps bound or limit the problem, and helps show relative importance of one concept to another.

Heuristics. Nonprogrammed decisions have traditionally been resolved by relying on the decision maker's judgement, intuition, and creativity (Nettleton, 1987:10). Nettleton states that modern approaches involve using heuristic problem-solving techniques for training human decision makers and for constructing heuristic

computer programs. A heuristic is defined by Webster's New Collegiate Dictionary as

> ... providing aid or direction in the solution of a problem but otherwise unjustified or incapable of justification. Specifically of or relating to exploratory problem-solving techniques that utilize self-educating techniques (as evaluation of feedback) to improve performance < a heuristic computer program >.

A heuristic is particularly useful for improving nonprogrammed decision making in that it provides structure and rationale to an otherwise unstructured process. A type of decision making heuristic which will next be reviewed is multi-criteria decision making.

Multi-Criteria Decision Making

As stated above, the problems facing managers and upper-level decision makers are characterized by their uniqueness, importance, uncertainty, and complexity. Rarely is a decision of this type made on the basis of a single factor, but rather is made in the presence of multiple, often conflicting, criteria. This type of decision making is commonly referred to as multi-criteria decision making (MCDM). Literature on MCDM has been reviewed extensively by Hwang and Yoon (1981). Although modern efforts to incorporate MCDM into the decision making process started only in the 1950s, the study of multi-criteria has a long tradition (Hwang, 1981:5).

Problems involving multiple criteria are commonplace in everyday life. The new automobile one purchases may depend upon its prestige, styling, and color in addition to gas mileage, engine size, and repair expectations. A business's decision for locating a new manufacturing plant may depend on location desirability, tax rates, raw resource availability, labor relations, and so forth.

Multi-criteria decision methods provide a framework for compiling and structuring the facets of an otherwise complex decision. Each alternative in MCDM is usually characterized by a number of attributes , i.e., car style, gas mileage, color, etc. (Hwang, 1981:16). Hwang explains that these attributes are performance measures which provide a means of evaluating each alternative. The attributes can be quantitative or qualitative. In the automobile example, gas mileage and engine size can be expressed in numerical or quantitative terms, but prestige and styling would be in nonnumerical or qualitative terms. The decision maker can also reflect relative importance of the attributes by assigning weights to the attributes. The area of MCDM which emphasizes the various attributes associated with the alternatives is referred to as multi-attribute decision making (MADM).

Selecting a MADM Methodology. A MADM method is a procedure that specifies how information about attributes is used to arrive at a decision. As the Taxonomy of MADM

Methods (Figure 4) shows, the MADM method applicable to a particular problem depends on the nature of the problem and the information available about the alternatives and attributes. There are two major approaches in attribute information processing: noncompensatory and compensatory models.

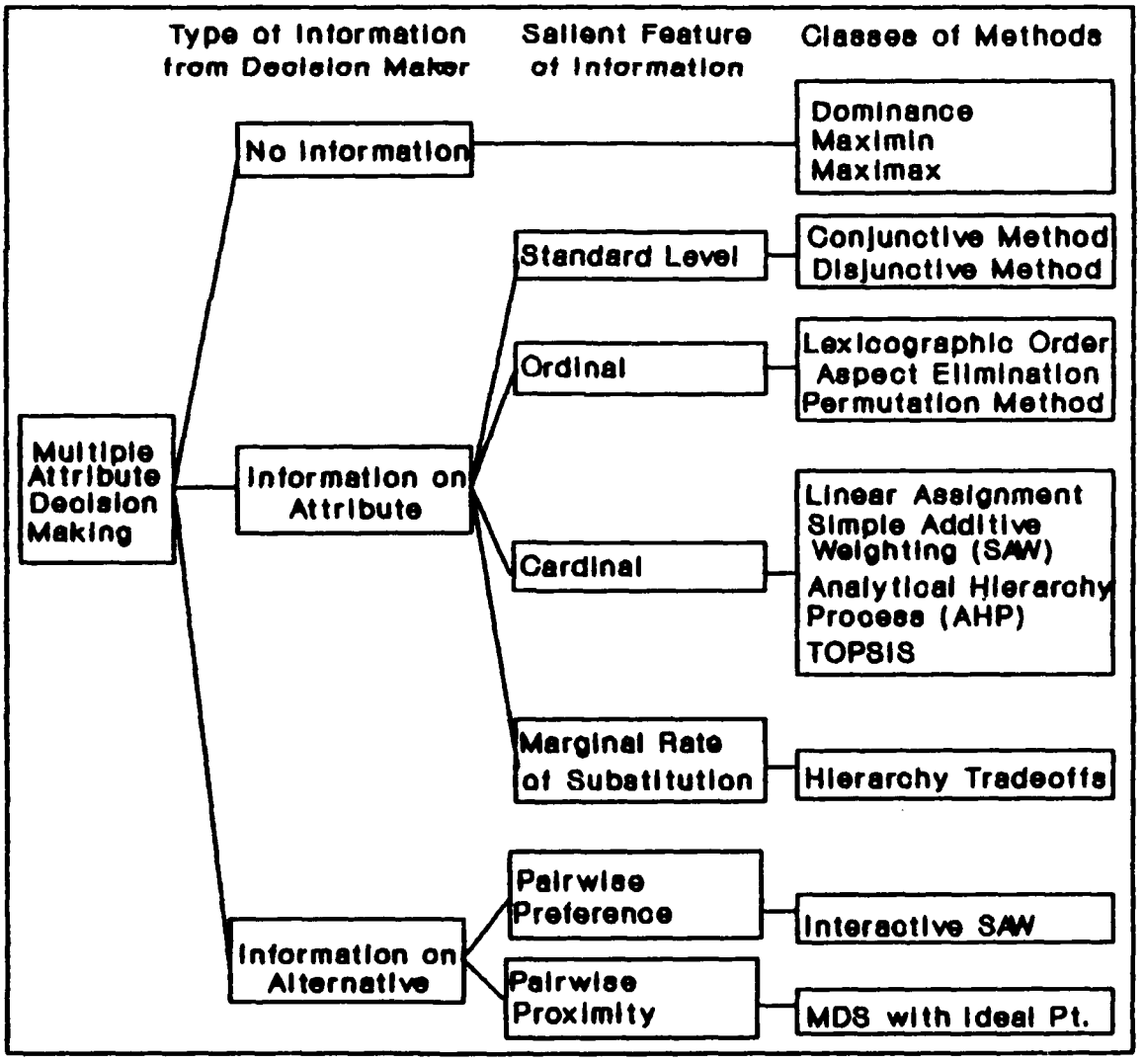


Figure 4. A Taxonomy of Multi-Attribute Decision Making Methods (from Hwang, 1981:6)

Noncompensatory Models. These MADM models do not permit trade-offs between attributes. A disadvantage or unfavorable value in one attribute cannot be overcome by an advantage or favorable value in some other attribute. Each attribute must stand on its own. Thus, comparisons are made on an attribute-to-attribute basis. The MADM methods belonging to this model are applicable where the decision maker's knowledge and ability are extremely limited. These methods are dominance, maximin, maximax, conjunctive constraint method, disjunctive constraint method, and lexicographic ordering.

Since prioritizing LNs depends on the interaction of several factors and the possibility to compensate for a poor attribute value with another area, the noncompensatory models are not appropriate for this problem.

Compensatory Models. Compensatory models permit trade-offs among attributes. Changes in one attribute can be offset by changes in other attributes (Hwang, 1981:25). Compensatory models require the decision maker's cardinal preference of attributes. This is most readily accomplished through a set of weights for the attributes. With this type of model, a single number is usually assigned to each attribute. Based upon the principle of calculating this number, compensatory models can be divided into three types:

Scoring Model. This model selects an alternative which has the highest score or maximum utility. The difficulty with these models is assessing the appropriate utility function. Models of this type include simple additive weighting (SAW), analytical hierarchy process (AHP), and interactive simple additive weighting.

Compromising Model. This model selects an alternative based upon its distance from the ideal solution. The closest alternative is preferred. TOPSIS and nonmetric MDS belong to this group.

Concordance Model. This model arranges a set of preference rankings which best satisfice a given concordance measure. Permutation method and linear assignment method are of this type.

TOPSIS. The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is a compromising model which selects an alternative having the largest relative closeness to the ideal solution (Figure 5). This is done by simultaneously evaluating the alternative's distance from the ideal solution and the negative-ideal solution.

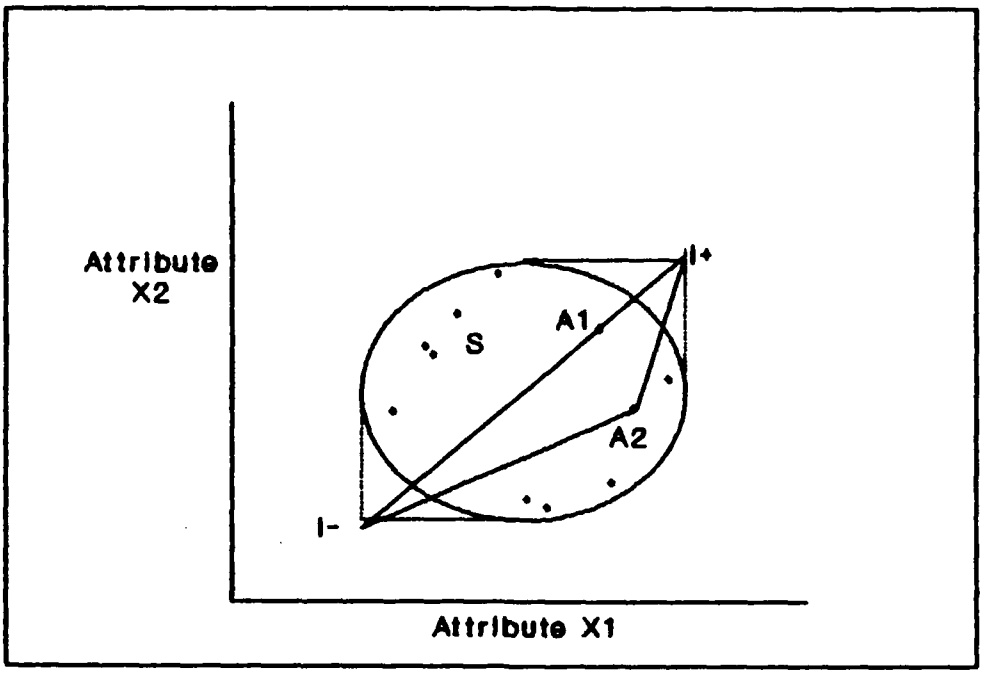


Figure 5. Distances to the Ideal and Negative-Ideal Solutions in Two Dimensions
(from Hwang, 1981:129)

Hwang explains that the TOPSIS algorithm consists of six steps:

1. Construct the normalized decision matrix.

This process transforms the various attribute dimensions into nondimensional attributes. This is done by dividing each outcome criterion x_{ij} (the numerical outcome of the i-th alternative with respect to the j-th attribute) by the norm of the total outcome vector. The element r_{ij} of the normalized decision matrix R is calculated as

$$r_{ij} = x_{ij}/(\Sigma x^2_{ij})^{\frac{1}{2}}$$

This also gives each attribute the same unit length vector.

2. Construct the weighted normalized decision matrix. The set of weights $w = (w_1, w_2, w_3, \ldots, w_n)$, $\Sigma w_i = 1$, from the decision maker are multiplied with each column of the R matrix producing the weighted normalized decision matrix V.

3. Determine the ideal and negative-ideal solution. The ideal solution, I^*, is composed of all best attributes attainable, and the negative-ideal solution, I^-, composed of all worst attributes attainable. The two created alternatives I^* and I^- represent the most preferable alternative and the least preferable alternative, respectively.

4. Calculate the separation measure. The separation distance between the alternatives is calculated by the n-dimensional Euclidean distance. The distance of an alternative from the ideal solution is

$$S_{i*} = [\Sigma_j (v_{ij} - v_{j*})^2]^{\frac{1}{2}} \quad i = 1,2,\ldots,m$$

and the distance from the negative-ideal solution is

$$S_{i-} = [\Sigma_j (v_{ij} - v_{j-})^2]^{\frac{1}{2}} \quad i = 1,2,\ldots,m$$

5. Calculate the relative closeness to the ideal solution. The relative closeness of an alternative with respect to I^* is defined as

$$C_{i*} = (S_{i-})/(S_{i*} + S_{i-}), \quad 0 < C_{i*} < 1, \quad i = 1,2,\ldots,m$$

If an alternative Ai equals I^*, then $C_{i*} = 1$. Similarly, $C_{i*} = 0$ if the alternative equals the negative-ideal solution. An alternative A_i is closer to I^* as C_{i*} approaches 1.

6. Rank the preference order. The alternatives can be ranked by descending order of C_{i*}.

Group Decision Making

With all the complexities and difficulties of making good decisions, many organizations employ a group approach to problem solving hoping that a group will make better use of information and experience.

> A group approach to problem solving is needed for dealing with the environmentally imposed demand for more information sharing in organizations; a demand that grows as the environment becomes more dynamic, uncertain, and turbulent. (Moffitt, 1988:5)

With the need for agreement by all the MAJCOMs and the wide range of LNs and required technologies, AFOLTA uses a group decision making process to rank-order the LNs.

Group Decision Making Process. Sylvia Richardson showed that the process of group decision making is similar to individual decision making in that "... the process of group decision making is one of understanding the problem, developing a wide range of solutions, evaluating them and choosing the best one" (Richardson, 1978:23). In group decision making, however, there is an added dimension to the decision process. The group decision making process has two

stages: 1) each decision maker makes a decision; and 2) the decision makers negotiate to reach a compromise decision (Kersten, 1985:237). Thus the complexity of the decision process has increased by the need to mediate an agreement between the group participants. How groups members reach their individual decisions and then how well they arrive at a mutually acceptable decision determines the group effectiveness.

To ensure the success of a group decision making process, the Small Business Commission reported that the conditions which affect the success of a group include:

1. The range of possible solutions is initially available.
2. The need for personal expression is limited.
3. Participants acknowledge the power of unified action.
4. Relevant information is available.
5. Communication between participants is available, but controlled. (Small Business, 1988:32)

Analysis of AFOLTA's decision making environment will specifically examine the existence of these conditions.

Group Decision Support Systems

With all the time and effort a group exerts in its decision making process, any tool or technique that could improve the efficiency and/or effectiveness of the group would be of benefit (Moffitt, 1988:5). One such tool designed to aid groups with their decision problems is a Group Decision Support System (GDSS). GDSSs are generally regarded as being "...computer-based systems that aid group

members in the identification, analysis, and resolution of tasks or problems" (Lewis, 1988:347).

Perspectives of GDSS. As Figure 6 shows, GDSSs incorporate elements and functions from several perspectives: system-based, organizational, human communication, management science, and decision making (Nunamaker, 1989:140).

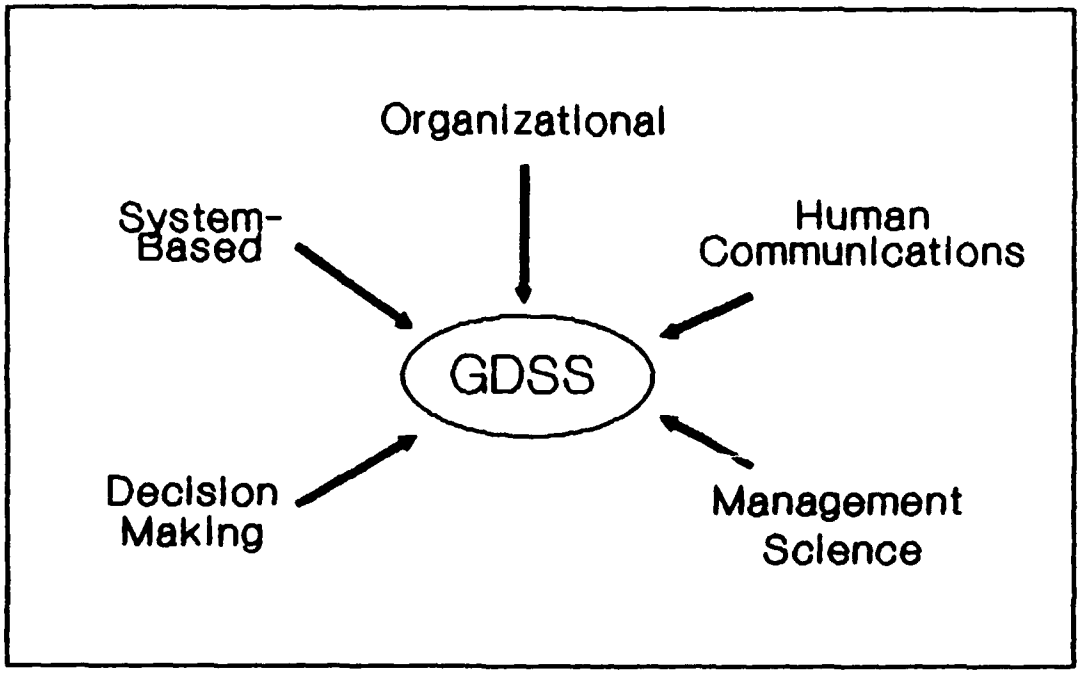


Fig. 6. Perspectives of Group Decision Support Systems (from Numamaker, 1989:140)

System-Based. A GDSS contains the qualities and functions of an information system. The system provides the decision makers with information relevant to their problem. Even more importantly, the GDSS helps provide understanding

of the presented information. Thus a GDSS provides functions beyond that of a traditional information system. A GDSS must be adaptable to changing circumstances, be able to address complex questions, and provide efficient interaction between the system and the decision makers (Nunamaker, 1989:141).

Organizational. A GDSS must be designed to operate within the organizational structure and context of the group it supports. A GDSS must be tailored to the organizational behavior -- the functions and methods -- of the group.

Human Communication. A great deal of the current research on GDSS has focused on the importance of improving communication between group members (Nunamaker, 1989:5, (DeSanctis, 1987:589). As noted above, the group process involves a great deal of communication especially as the group members negotiate a mutually agreeable solution.

> GDSSs improve group decision process by removing common communication barriers, providing techniques for structuring decision analysis, and directing the pattern, timing, or context of the discussion. (DeSanctis, 1987:589)

At a recent professional conference, Paul Gray proposed that "In GDSS, GDSS should stand for Group Deliberation Support Systems" (Gray, 1989). Thus GDSSs emphasize and work to improve and facilitate effective communication among group members.

Decision Making. GDSSs improve decision making by containing functions aimed at the "...sensing, exploration, and definition of problems.....as well as the generation, evaluation, and selection of solutions" (Nunamaker, 1989:142). A GDSS provides tools to record the rationale and justification for a particular decision. Such a system eases the complexities associated with uncertainty and helps the decision maker structure the problem.

Management Science. GDSSs bring together applicable models and analytical techniques which could aid the decision makers.

> Multi-criteria decision making models are particularly relevant to GDSSs. Group members typically confront a broad spectrum of factors that are important considerations in arriving at a final decision. (Nunamaker, 1989:143)

Regression models, optimization algorithms, and other techniques appropriate to the decision problem could also be included in a GDSS.

Levels of GDSS. DeSanctis (1987:593-595) categorizes GDSSs into three levels. Level 1 GDSSs provide technical features aimed at removing common communications barriers, such as large screen displays and electronic information exchange between group members (known and anonymous). Preliminary systems of this type are in place in corporate "electronic board rooms." Level 2 systems expand on Level 1 by adding automated planning tools or decision analysis tools for analytical, quantitative support. Level 3 GDSSs

are characterized by machine-induced group communication patterns. These may contain all the features of the two lower level systems, but now information exchanges and group interactions are governed by group rules monitored and directed by the GDSS.

Impact of GDSS on Group. In addition to improving communication between group members and presenting applicable information in a useable manner, Pinsonneault describes five ways that a GDSS impacts a group:

> 1. Focuses the efforts of group members towards the problem. Increases the depth of analysis.
> 2. Increases the overall quality of effort put in the decision process by the group. Increases participation, decreases domination.
> 3. Increases consensus reaching. Greater participation (2) combined with heightened focus of attention (1) leads to higher consensus reaching.
> 4. Increases quality of decision and the confidence and satisfaction of group members with the decision.
> 5. Increases group members' satisfaction with the decision process. (Pinsonneault, 1989:205)

Designing a GDSS through Storyboards. GDSS design involves the evaluation of the requirements for the various aspects Nunamaker noted. The decision process, information needs, communication requirements, analytical support, in addition to decision maker-specific requirements need to be evaluated. While identifying the required components of a GDSS is a major part of the design effort, it is eventually necessary to visually describe how these components would be combined in the intended system.

Storyboards are often used to depict the intended GDSS. Andriole defines a storyboard as "a sequence of displays that represent the functions that the system may perform when fully implemented" (Andriole, 1987:3). These screen representations show the system functions, available operations, models, and user interfaces of the intended system. From a fully developed set of storyboards, a software engineer would proceed to build the operational GDSS.

Summary

The MAJCOM Coordinating Committee tasked with ranking LNs needs to synthesize a vast amount of unfamiliar information and then arrive at an agreeable solution. A GDSS that would incorporate functions of information presentation/explanation, communications, scoring and ranking, and justification recording would be of benefit to the AFOLTA and to the participating MAJCOMs.

Applying a multi-attribute decision making technique as part of the GDSS provides an effective way for combining the diverse elements of the problem. It would add structure to an otherwise unstructured decision process. Such an application provides the decision maker a process whose steps, although potentially difficult to explicitly define, move the decision maker through the three phases of decision making: intelligence, design, and choice. The LN

prioritization problem contains each of Howard's attributes of a decision: uniqueness, importance, uncertainty, long run implications, and complex preferences. The solution to AFOLTA's annual responsibility for prioritizing LNs -- a complex, unstructured decision problem -- lies in the understanding and application of the topics which have been reviewed.

In the next chapter, the specific methods and approaches selected to achieve the research objectives are presented.

III. Methodology

Having examined the prescriptive theory and methods which apply to the LN prioritization problem, this chapter addresses the specific techniques and actions used to accomplish the research objectives.

Describe the Decision Process

The LN Process. Describing the process of identifying and prioritizing LNs was accomplished by interviewing several of the the participants and organizers of the MAJCOM Coordinating Committee conference. Concept maps were used where possible during these interview sessions as a tool for capturing the knowledge and understanding of the person being interviewed. As mentioned in Chapter 2, concept maps are a dynamic, user-oriented tool hand-drawn on paper or a chalkboard. Copies of the original, hand-drawn concept maps are in Appendix A. The overall decision problem referenced in a concept map can be decomposed and analyzed by extracting segments of the concept map for further detailed study.

As described in Chapter 1, the LN process involves numerous Air Force organizations ranging from the Air Force Deputy Chief of Staff for Logistics and Engineering (USAF/LE) to the various MAJCOMs and their operational units. Figure 7, extracted from a concept mapping session (Nenninger, 1989), shows the specific responsibilities and information flow in the LN process. Note how AFOLTA has the major

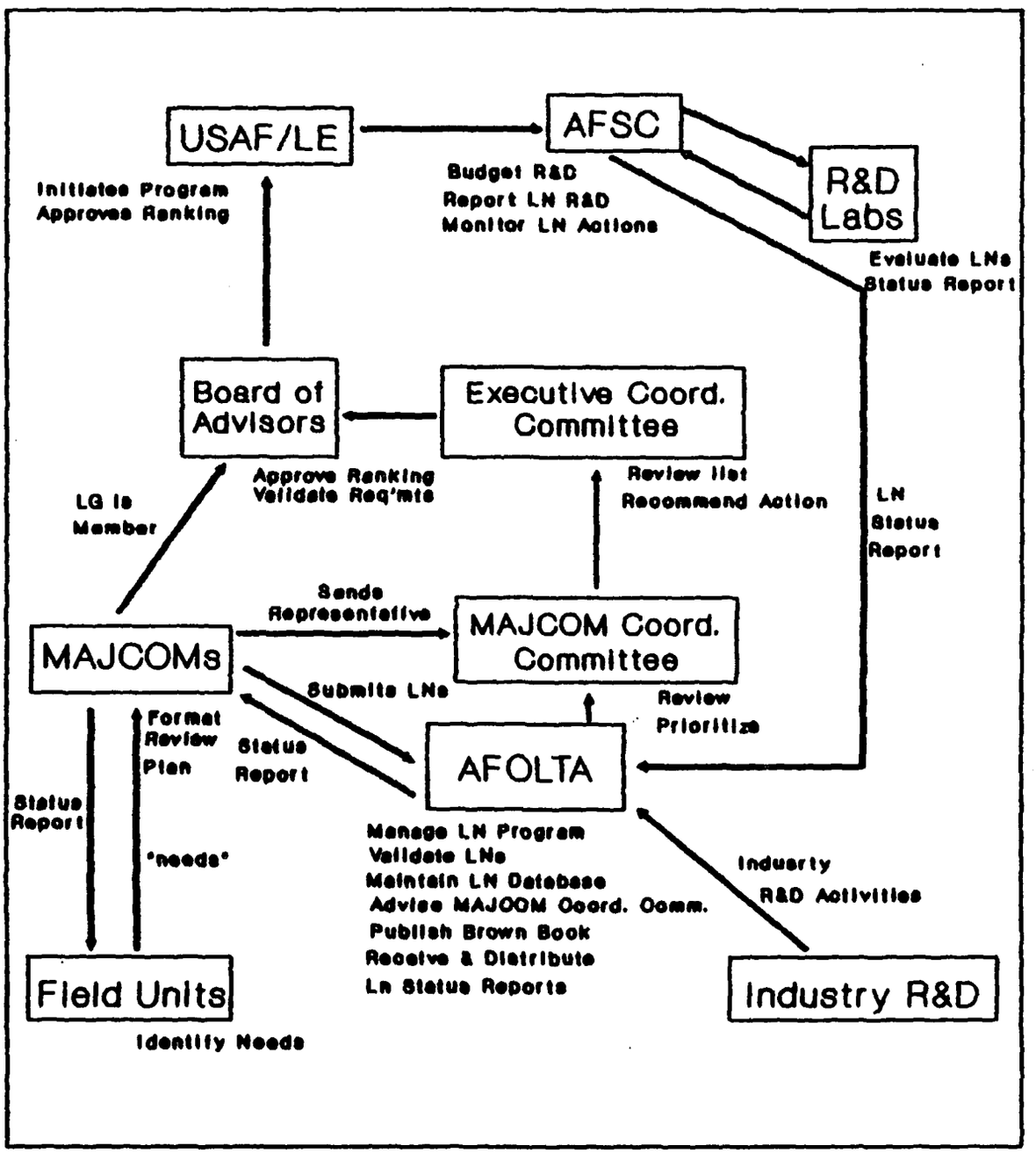


Figure 7. Responsibility and Information Flow in the LN Process

responsibility for the LN Program: validating, overseeing, monitoring, providing feedback, and managing the LNs.

Three new Air Force regulations, approved for publication but not yet distributed, substantiate and institutionalize these responsibilities (AFR 80-33, AFR 20-7, and AFR 23-35). The regulations maintain AFOLTA's central role in the LN Program. AFR 80-33 mentions that AFOLTA is responsible for managing the entire LN Program, maintaining and updating an LN database, validating LN submissions, receiving and distributing LN status reports, administrating the LN prioritization effort, and publishing those results as the Brown Book.

Prioritizing LNs. As part of managing the LN Program, AFOLTA is responsible for ensuring that LNs are reviewed and prioritized by the MAJCOM Coordinating Committee (AFR 80-33). Interviews and the concept maps (Appendix A) resulting from those sessions provided understanding of the current prioritization process.

Before convening the MAJCOM Coordinating Committee, AFOLTA sends each MAJCOM an entire list of LNs to prioritize. Starting with the previous year's ranking, each MAJCOM ranks the entire list of LNs. Newly submitted LNs are folded into the ranking in their perceived "proper" position. These rankings are called the initial ballot and are collected at the opening of the Committee session. The MAJCOM's initial ballots are combined into a single group

ranking by averaging the ranking of the LNs:

$$\text{Ranking of } LN_i = (\Sigma_j LN_{ij})/n$$

where n is the number of decision makers, LN_i is the ith LN and LN_{ij} is the priority assigned by the jth decision maker on the ith LN. This method produces an average ordinal score.

Following the initial ballots, the committee discusses the rankings, presents their MAJCOM's position on certain LNs, and clarifies their understanding of the LNs. Then the members complete another ballot, re-ranking the entire list of LNs which are all combined into a new group ranking. This cycle continues until a mutually agreeable list is achieved (Fig 8). This entire process is accomplished separately for Research Needs (LRN), Development Needs (LDN), and Application Needs (LAN).

The MAJCOM representatives to the committee are generally familiar with their own MAJCOM-sponsored LNs. They are, however, mostly unfamiliar with the majority of LNs sponsored by other MAJCOMs. The only actual LN data provided to the committee is the Brown Book description of each LN -- a one-to-two page typewritten summary. Using this information, the committee members prioritize LNs based on their perception of the benefits that the LN provides

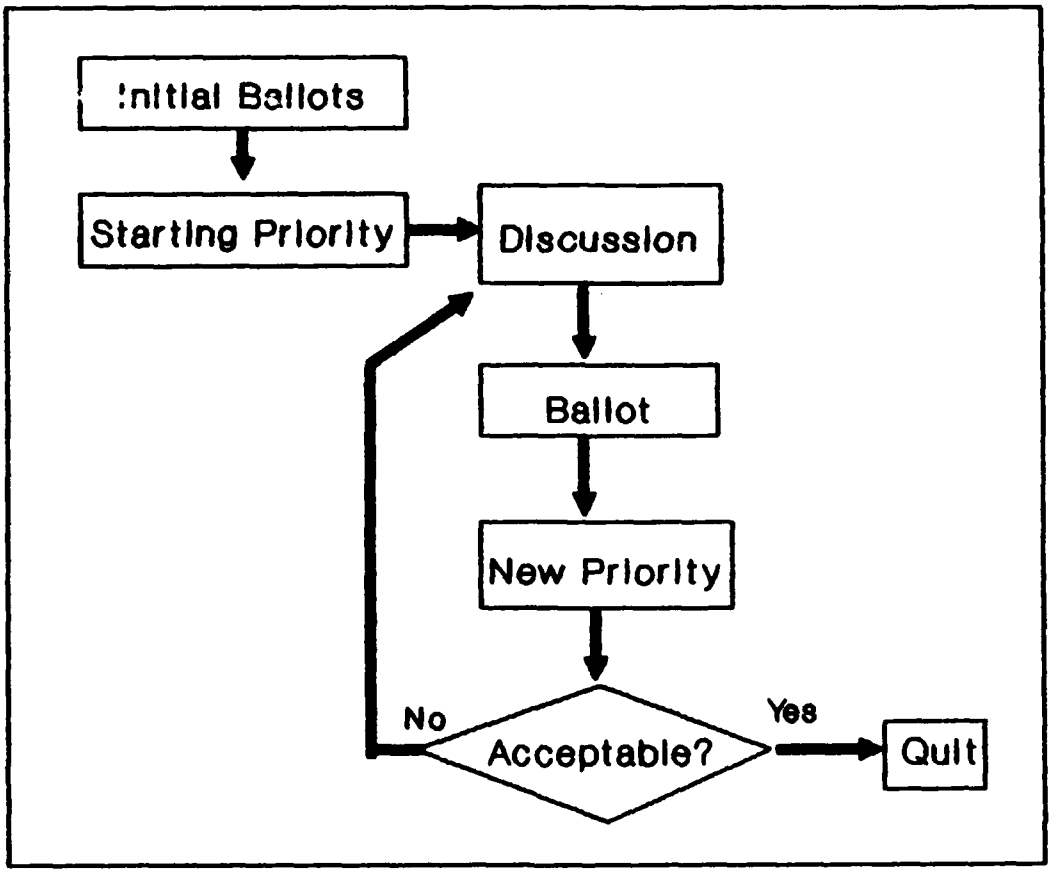


Figure 8. The Group LN Prioritization Process

relative to all LNs, the priorities of their MAJCOM, and the discussion with other committee members (Long, 1989), (Usrey, 1989).

Concerning the priority of LNs, the committee members felt confident that the top 15 to 20 LNs were properly ordered (within a position or two). Below that point, however, relative position was more important than the actual ordinal ranking for determining an LN's importance (Long, 1989), (Usrey, 1989).

Participant Qualifications. AFOLTA requests that each

MAJCOM have a senior-level officer (colonel) as its representative to the MAJCOM Coordination Committee. Several MAJCOMs disregard this request, by sending instead a lower-ranking but also highly-qualified representative.

A survey of the participating MAJCOMs was developed and sent to each Deputy Chief of Staff for Logistics (Appendix B). These senior officers participate in the LN Program in several ways: 1) serving on the Board of Advisors, 2) directing logistics activity within their MAJCOM, and 3) supervising the representative to the MAJCOM Coordinating Committee. With a strict nonattribution policy to encourage candid responses, the survey solicited the opinions and understanding of these senior logistics officers concerning several aspects of the LN Program. Questions in the survey dealt with the MAJCOM's identification and validation process, the desirable qualifications of MAJCOM Coordinating Committee members, and general impression and satisfaction with the LN Program. From the responses to the survey, a profile of the "ideal" or "desired" MAJCOM representative was developed.

Criteria for Prioritizing LNs. As mentioned above, each MAJCOM Coordinating Committee representative prioritizes LNs using their perceptions of some set of criteria for evaluating the relative importance of the LNs. These criteria had never before been explicitly identified. Through a Delphi survey patterned after Khorramshahgol's

Delphic Hierarchy Process (DHP), a methodology for priority setting derived from the Delphi method and AHP (Khorramshahgol, 1988:347), the MAJCOM representatives identified these criteria.

The DHP survey was conducted in three rounds. Rounds 1 and 2 were devoted to identifying and weighting criteria for ranking LNs while Round 3 was a test of the MCDM model. In Round 1 (Appendix C) the decision makers listed the criteria (referred to as factors) they considered, or felt should be considered, when prioritizing LNs. In addition to merely listing the various factors, the participants were asked to define and describe the factors. Then they were asked to rank the factors, scoring them on a scale of 0 to 100. The most important factor received a weight of 100 and all others were compared against it.

After receiving responses to Round 1, the results were compiled and included in Round 2. The second round (Appendix D) provided the decision makers with the group knowledge from Round 1. With the full list of factors and their weights, the participants were asked to re-weigh the factors in light of this information. The result of Round 2 was a set of well-defined factors and their weights for prioritizing LNs.

LN Information. AFOLTA maintains a large database of LN information. Table II lists the types of information available for each LN in the database. This information is collected from the LN submissions provided by the sponsoring

Table II. Information Fields of the LN Database

File Number	Technology Area
Accession Number	Status 81
Last Update Date	Status 82
Weapons System	Status 83
Page for Index Use	Status 84
LNAO	Status 85
Product Division	Status 86
Short Title	Status 87
Book Page Number	Status 88
Logistics Need ID	Status 89
Title	Interim Products
Objective	Current Sponsor
Problem	Original Submitter
Related Efforts	Co-Sponsor(s)
Combat Support Category	Potential User(s)
Suggested Approach	Implementation Planning
Key Words	Cross Reference
References	LN Category Audit Trail
Deliverable Requirement	Final Results
LN Connection	Payoff/Benefit
Point-of-Contact	LN Category
MAJCOM LN POC	LN Manager
AFOLTA LN Manager	Lab Responses 89
Actions Agency	Tech Avail Date
Proposed Support	Response Completeness 89
Other Agencies	LN Impact 89
Program Year	Previous Rank

MAJCOMs, by research laboratories in contact with AFOLTA, and by AFOLTA's LN managers. The database information is generally updated annually as status reports and new submissions are received.

The LN database contains approximately 4.8 million characters of information and is established in the BASIS database system. This database environment is especially suited for databases containing great amounts of textual data (Anderson, 1989). BASIS provides search capability for a

phrase within any field -- useful when searching for some technical phrase or remark. There is no relational capability within BASIS, a potential disadvantage to the system. Output from the database is provided in tabular report formats. The Brown Book format is one such report format.

Quite recently, AFOLTA made the database available to the MAJCOMs on a dial-up, read-only basis (Gomez, 1989). Through this service, MAJCOM LN managers can potentially receive status report updates and better monitor their LN interests.

Other Air Force organizations maintain partial databases relating to LNs. Within AFSC, several of the research laboratories maintain databases of their activities and the state of their research (Harshberger, 1990). Additionally, several offices within Aeronautical Systems Division's Wright Research and Development Center have databases of their technology developments (Harshberger, 1990). There is not, however, dial-up accessibility to any of these databases at the current time.

MCDM Model. As discussed in Chapter 2, a compensatory MCDM model was most applicable to the LN ranking problem. Such a model allows for trade-offs among attributes; a poor score in one area can be offset by a good score in another attribute. Of the several compensatory methods, TOPSIS was chosen because its information requirements relied on

evaluating a set of attributes versus requiring the decision maker to indicate preference between alternatives (need to decompose the problem into evaluating attributes, not trying to evaluate an LN by looking at it as a whole). Additionally, the TOPSIS preference structure is based upon relative closeness to the prime ideal -- a good cardinal indicator of the value of an LN and readily understandable by most decision makers. Finally, the TOPSIS algorithm was readily available and easy to implement.

Testing the MCDM Model. Round 3 of the DHP survey (Appendix E) had the participants actually use the factors identified in the first two rounds to score a sample set of LNs. First, the MAJCOM representatives were presented with a list of 12 LNs from the Brown Book. Using the Book description, they were asked to prioritize the LNs much as they had done while meeting with the MAJCOM Coordinating Committee.

Next, in the second part of Round 3, the participants were given a score sheet for each LN (Figure 9). Again using the Book description and their personal understanding of the LNs, they were asked to score each LN by assigning values to the attributes. These scores were calculated in the TOPSIS model and the results were compared to the ordinal ranking for each decision maker and for the combined, group rankings.

LN# _____ TITLE: _____

Indicate with a circle or "X", the score you assign each attribute for this LN.

Attribute	Score (0 — 50 — 100)
Mission Impact	
Pervasiveness	
Reliability & Maintainability	
Payback	
Cost	
Safety Impact	
Feasibility/Prob of Tech Success	
_____	
_____	
_____	

Figure 9. LN Attribute Score Sheet

Apply GDSS Concepts

Accomplishing the above research agenda was designed to provide the information needs, communications requirements, and a fairly thorough understanding of the LN decision process. This knowledge should lead to the design of a GDSS.

Define AFOLTA's Needs. A GDSS is intended to enhance the group decision making process. The functions of the LN prioritization effort which could be incorporated into a GDSS were identified through the concept maps of interviews with the group participants. Figure 10, extracted from original concept maps (Long, 1989) and (Usrey, 1989), depicts that the MAJCOM Coordinating Committee members' effort of prioritizing LNs relied on information from the LN database (essentially the Brown Book information), discussion with the other members of the committee, and translating that information through some set of LN attributes. Thus a GDSS for prioritizing LNs must include functions for information presentation, communication, and LN attribute scoring/analysis.

The priority for implementing these functions would be based on their applicability to one of DeSanctis' three levels of GDSSs. Information presentation/management functions would be initiated first, followed by group communication capabilities. As a minimum, these communication functions would allow each member to

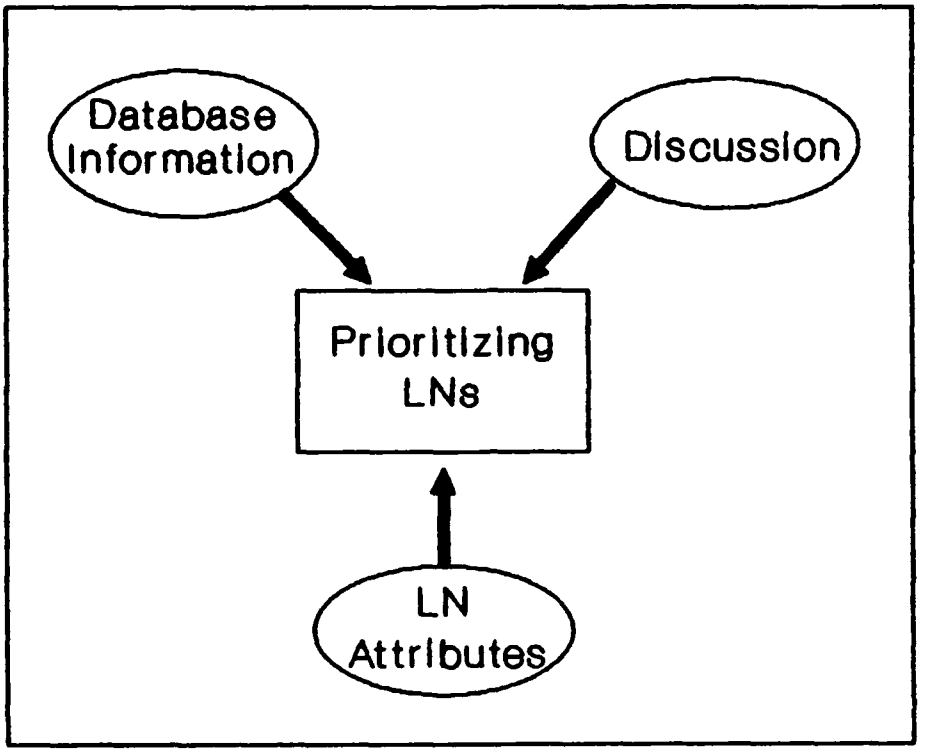


Figure 10. Components for Prioritizing LNs

communicate electronically with every other group member and also have access to a public display. These messages could be sent anonymously if desired. With these functions in place, the analytical functions of the MCDM model would be included. This model would include attribute definition and weighting, value assignment,and a prioritization algorithm. Needed also would be a means for documenting the decision logic and reasoning for future reference.

Design a Kernel System. The concept maps of the user's perception of the ranking problem indicate that the central

issue in prioritizing LNs was having access to pertinent information and being able to combine that information in order to assess the relative importance of each LN (Long, 1989), (Usrey, 1989). Discussions indicated that a lot of desired information was not readily available when ranking LNs. Therefore, the design of the kernel system -- the initial base system from which a full GDSS evolves -- was an information management system supporting a multi-attribute decision making model based on the attributes derived using the Delphi process.

Storyboards depicting the screen representations of the kernel system were developed (Appendix G). The design of the kernel system provides the available, relevant information about the LNs to the decision makers in an understandable format. This information directly supports the decision makers' judgements required in the multi-attribute decision making model, providing a methodology for combining the information.

Prepare Roadmap. Knowing AFOLTA's needs and priorities and the capabilities of a GDSS, a graphical PERT-like chart was developed to provide an overall plan for evolving to a GDSS from the manual LN prioritization process. Decision points and options are presented in the roadmap.

Summary

Accomplishing the tasks described in this chapter

produced a wealth of information about the LN Program and the process of prioritizing LNs. The next chapter presents the results of the research and provides analysis of those results.

IV. Results and Analysis

This chapter reports the results of the research agenda described in the previous chapter and presents analysis and understanding of those results. The results of the surveys and other research methods have been decomposed and are presented according to topic.

LN Prioritization Process

Examining the MAJCOM Coordinating Committee's process of prioritizing LNs, an iterative balloting and discussion process, raises concerns relating to each of Simon's three phases of decision making: intelligence, design, and choice.

Intelligence Process. Currently the MAJCOM representatives have only the Brown Book description of the LNs when making their prioritization decision. Except for those LNs sponsored by their own MAJCOM, the majority of LNs are unfamiliar to most of the committee members. This makes the ranking decision even more difficult and even more subjective. The discussion period between ballots assists to clarify and define the importance of the LNs, but this new information is subject to the presenter's biases. Often the discussion becomes a "soap-boxing" exhortation for a MAJCOM's pet project. The need for better, more substantiative data presented in a proper format is critical to meeting the "intelligence" requirements for this decision problem.

Design Process. Simon's design phase has the decision maker determining the method for solving the problem. Currently the task of prioritizing LNs is decomposed into three sub-lists: Research Needs (LRN), Development Needs (LDN), and Application Needs (LAN). For each list, the committee members rank each LN from 1 to the number in the list. The ordinal rankings are averaged across all decision makers and ordered in descending order to produce a group ranking.

As the decision makers complete their ranking ballots, they are relying on their subjective assessment of the information available to them and interpreting that data through some set of unidentified criteria. Further, the LNs are so varied and diverse it is often extremely difficult to compare the relative value of a pair of LNs.

The lack of common, or at least identified criteria for prioritizing LNs is a deficiency in the current method. AFOLTA does encourage the MAJCOM representatives to take an Air Force perspective in their prioritization effort, but do not explicitly define what that means.

Choice Process. In the 1989 MAJCOM Coordinating Committee session, there were 107 LRNs, 75 LDNs, and 35 LANs. With such large numbers, particularly in the first two groups, the committee members concluded that they were comfortably confident that the top 10 or 15 LNs were in the proper position (within a place or two), but below that only

the relative ranking was an indicator of importance. One committee member explained that an LN ranked fortieth in the list was essentially similar to the forty-fifth or even the fiftieth ranked LN (Long, 1989). In a list of over 100 LNs, such as the LRN list, not being fairly certain of the majority of the list is a serious deficiency.

Participant Qualifications

The responses to the survey of MAJCOM LGs provided a robust insight to the expectations that senior logistics officers have of the LN Program and of those who represent their MAJCOMs in the program. Responding to the question concerning the desired background or experience for a MAJCOM representative, the desire seems to be for a "logistics generalist" (Fig 11). The LGs felt that the representatives to the committee particularly needed a strong background in logistics or maintenance.

In addition, many felt the representatives should have experience in the Air Force acquisition and budgeting process, technology development, the LN Program, and also be familiar with staff functions and duties. This "ideal" representative is familiar with his own MAJCOM's LNs and has the necessary expertise to evaluate the merits of other MAJCOM's LNs with respect to his own.

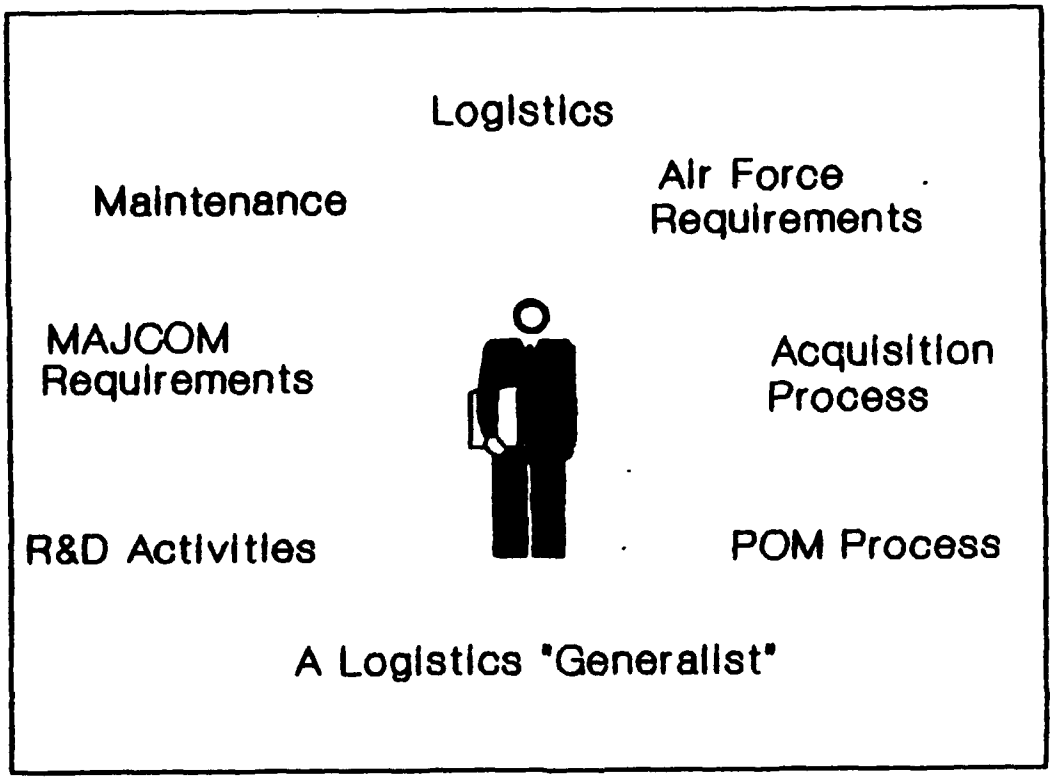


Figure 11. MAJCOM Representative Qualifications

The MAJCOM LGs were mixed in their opinion of AFOLTA's request for each MAJCOM's representative being a colonel or civilian equivalent (Fig 12). Several felt that such a request was not unreasonable, but that a firm requirement for a colonel was unnecessary. The individual responsible for being the MAJCOM LN focal point was most often identified as the best representative to the MAJCOM Coordinating Committee, regardless of rank.

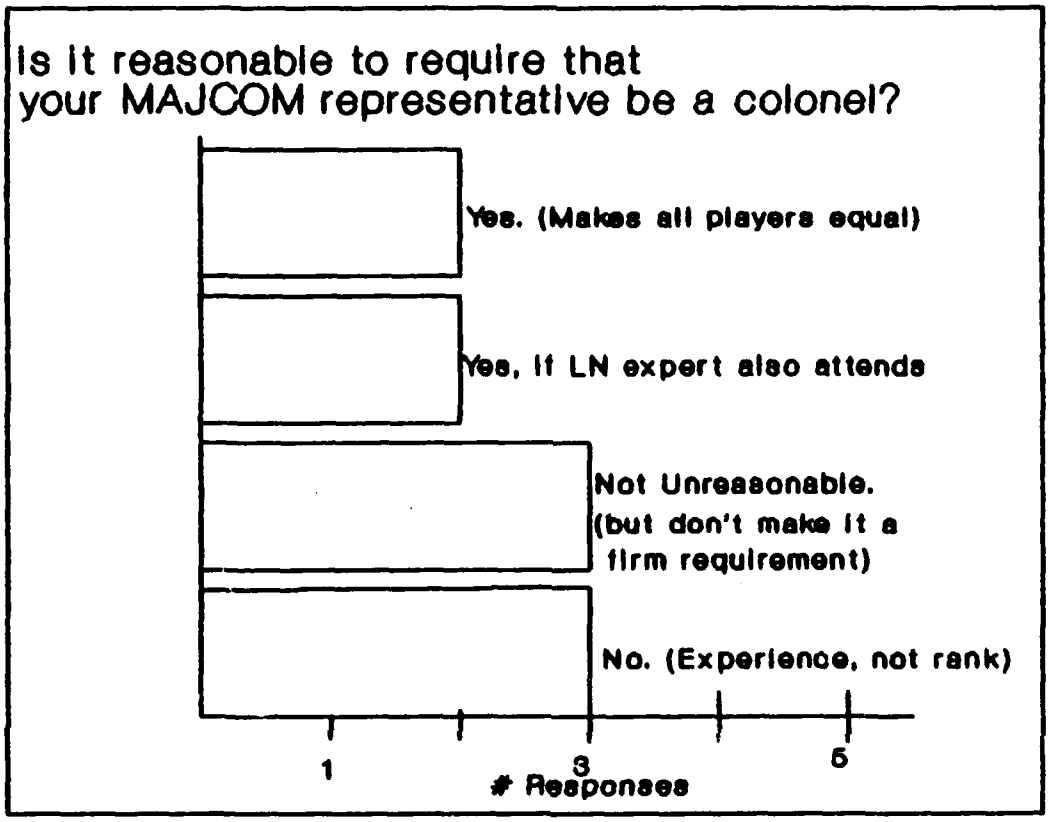


Figure 12. Responses to Requirement for MAJCOM Representative Being a Colonel

Criteria For Prioritizing LNs.

With the desire to improve the method of prioritizing LNs and allow for more direct comparison of LNs, Rounds 1 and 2 of the DHP survey were conducted to establish the factors used by the MAJCOM representatives when prioritizing LNs. These attributes and their weights were initially identified in Round 1 and then refined in Round 2.

Identifying Factors and Weights. The responses to Round 1, identifying and weighting factors for LN prioritization are summarized in Table III. The nine decision makers identified 20 distinct factors. Several respondents mentioned similar factors with only semantic differences which were combined without loss of meaning or intent. Eleven of the attributes were identified by more than one decision maker and seven of these were mentioned by four or more respondents.

Table III. Round 1 Summary: Factors and Weights

Factor	Avg Weight	Percent Favoring	Final Weight
Pervasiveness	80.00	88.89	71.11
Mission Impact	75.00	77.78	58.33
Feasibility	70.00	66.67	46.67
Payback	70.00	55.67	28.89
Cost	52.00	55.56	28.89
Reliab.& Maint.	63.75	44.44	28.33
Command Interest	47.00	55.56	26.11
Safety	85.00	22.22	18.89
Prob. of Funding	80.00	22.22	17.78
Threat Impact	77.50	22.22	17.22
Timeliness	65.00	22.22	14.44
Importance to Sponsor	100.00	11.11	11.11
Consistency w/ Goals	75.00	11.11	8.33
Need vs Want	70.00	11.11	7.78
Application Horizon	50.00	11.11	5.56
effectiveness	40.00	11.11	4.44
Usability	40.00	11.11	4.44
Spin-off	35.00	11.11	3.89
Work Arounds	20.00	11.11	2.22
Item Life Expectancy	10.00	11.11	1.11

The final weight for each attribute was calculated based on two factors: 1) the average weight for an attribute, and 2) the percentage of participants favoring it. The reason for considering the two factors was to reduce the weight for an attribute that may have a high average weight but may not be highly favored. For example, the factor Importance to Sponsor weighed 100 but was chosen by only one participant; in other words, all participants but one thought it should not be considered for further analysis.

Re-Weighting the Factors. In Round 2, the decision makers were presented the list of 20 factors and their definitions (Appendix D) from Round 1 rank-ordered by their weights. They were asked to re-weigh these factors in light of the group knowledge. Those MAJCOM representatives who did not participate in the previous round were invited to join this round. Table IV summarizes the results of Round 2. The final weights were calculated in the same manner as in Round 1.

Comparing the factors from the two rounds with those identified in concept mapping sessions (Long, 1989) and (Usrey, 1989) indicate several similarities. The final weights of the top seven factors are all well above the 50 point, or midpoint score. Due to this and consistency with the concept maps, only the top seven factors (and their normalized weights) were used in the remaining analysis.

Table IV. Round 2 Summary: Factors and Weights

Factor	Avg Weight	Percent Favoring	Final Weight	Norm Weight
Mission Impact	90.83	100.00	90.83	16.69
Pervasiveness	89.92	100.00	89.92	16.52
Reliab. & Maint.	76.08	100.00	76.08	13.98
Payback	75.42	100.00	75.42	13.86
Cost	74.67	100.00	74.67	13.72
Safety	72.08	100.00	72.08	13.24
Feasibility	65.25	100.00	65.25	11.99
Command Interest	50.83	100.00	50.83	
Consistency w/ Goals	52.45	91.67	48.08	
Prob. of Funding	48.30	83.33	40.25	
Threat Impact	47.80	83.33	39.83	
Timeliness	47.20	83.33	39.33	
Need vs Want	43.20	83.33	36.00	
Effectiveness	46.67	75.00	35.00	
Usability	42.11	75.00	31.58	
Item Life Expectancy	41.89	75.00	31.42	
Application Horizon	33.80	83.33	28.17	
Importance to Sponsor	32.80	83.33	27.33	
Spin-off	23.89	75.00	17.92	
Work Arounds	30.14	58.33	17.58	

Additional informal study indicated that the identified attributes fall into three broad categories: benefit, feasibility, and cost. The Hierarchy of Attributes (Fig 13) shows that decision makers rely heavily on the benefit attributes when ranking LNs.

The benefit branch contains the attributes which measure the positive impact of the LN to the Air Force. The sum of the normalized weights of this branch total 74.29. The feasibility branch consists of the factors which aid in

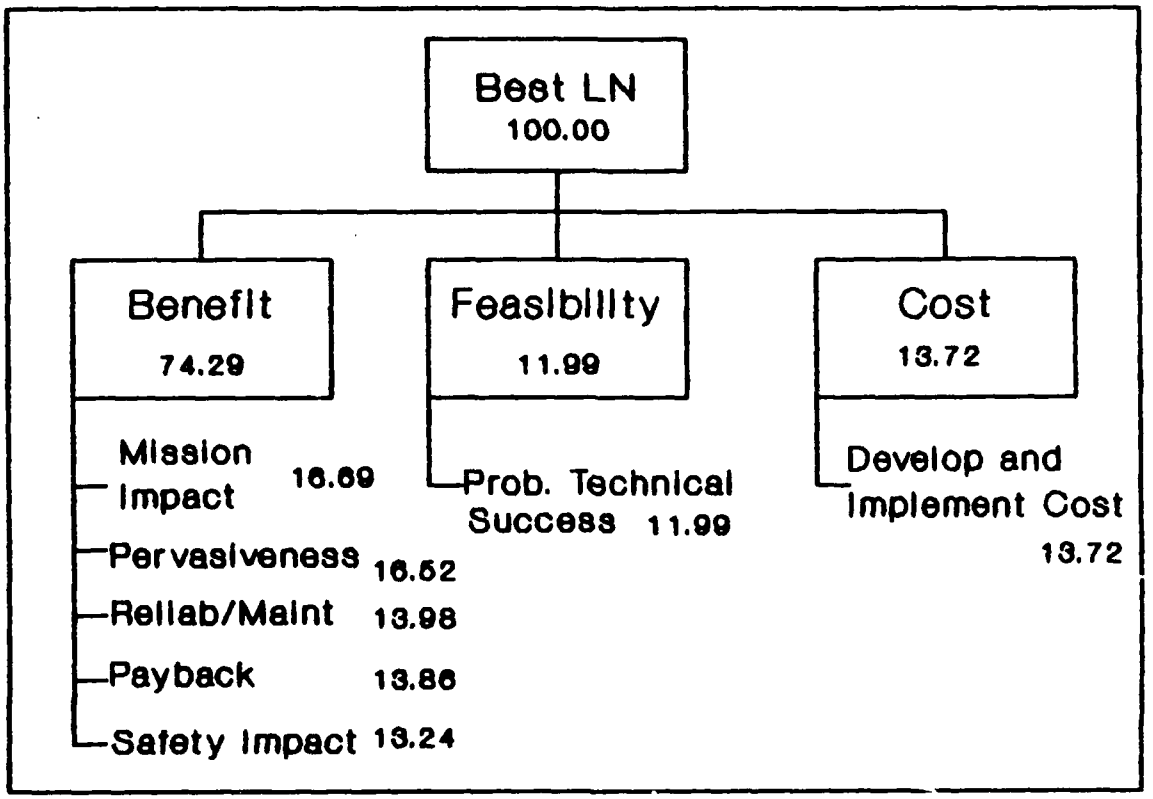


Figure 13. Hierarchy of Factors for Prioritizing LNs

assessing the success potential of an LN. The total normalized weight for the feasibility branch is 11.99. The cost branch contains the attributes associated with cost. Unlike the other attributes whose maximum value is most desired, this branch is optimal when minimized (least cost). The total weight for the cost branch is 13.72.

Identifying and weighting the factors associated with prioritizing LNs was a major step in formulating a methodology for assisting in the ranking process.

LN Information

LN Information Availability vs Requirements. With the identification of the factors the MAJCOM representatives considered and want to consider when ranking LNs, it was necessary to examine the availability of data to support those information requirements. There is a vast amount of desired information, most of which is not in the LN database.

Focusing on the top seven factors identified through the DHP survey Rounds 1 and 2, there is very little in the LN database to support these factors. Other than what can be gleaned from the brief problem statement, there is no real measurable information on mission impact, pervasiveness, reliability and maintainability improvement, or impact on safety. Although there is a data field for current status, the lab reports which provide that data do not indicate probable costs, possibility of meeting the need, or feasibility of technical success. Without such information it is nearly impossible for the decision maker to form a judgement of the potential payback.

In their responses to the survey, the MAJCOM LGs had very strong remarks concerning the need for better feedback and better status reports. As one respondent noted, "until we know if something is 'do-able' or obtainable, why rank it, fund it, or make plans around it? And if is not 'do-able', remove it from the list."

LN Database. An important feature of accessing a database is the ability to "browse" through the information in an informal, free-flowing manner. Data browsing requires the database be flexible enough to provide the decision makers the information in the manner and combinations they desire. Initial analysis of the data and database requirements to support the data browsing functions of a GDSS indicate the need for the current LN database to be broken-down into several smaller, related databases. Table V shows the principle databases required for a GDSS: Logistics Needs, Technical Area, Lab Report, Sponsor, Ranker, R&D Activity, and Attribute.

These databases would not need to be on one system or reside with one organization. AFSC could establish and maintain a database of Lab reports and technology developments (somewhat as they do now, only expanded and formalized). These several databases would be available for all users via a network. Additionally, responsibility for maintaining the databases would be shared by the offices responsible for the data.

Table V. Relational Databases Required for a GDSS

Logistics Needs Database
- LN Number
- Title
- Objective
- Problem
- Origination Date
- Last Update Date
- Sponsoring MAJCOM
- MAJCOM POC
- AFOLTA LN Manager
- Co-Sponsors
- Technical Area
- Related Efforts
- Payoff/Benefit
- R&M 2000 Impact

Lab Report Database
- Lab Name
- Location
- Report Date
- LN Number
- Feasibility Assessment
- Development Timeline
- Alternate Solutions
- Technology Area
- Other Applications
- Lab POC
- Other Labs working this issue

Technical Area Database
- Name
- Important attribute(s)
- AFOLTA Manager(s)
- Technologies within Area
- Definition

Sponsor Database
- MAJCOM name
- MAJCOM LN Manager
- LN Implementation Plan
- MAJCOM Issue(s)
- Priorities (within)
- Priorities (all LNs)

R&D Activity Database
- Lab/Corporate Name
- Location
- POC
- Technical Area of Work
- Progress Report
- Date of Work
- Projected Progress

Ranker Database
- Name
- Grade
- MAJCOM
- Office
- Ranking Date
- Attributes Used
- Weights of Attributes
- Priority List
- #1 LN
- #2 LN, etc.

Attribute Database
- Name
- Definition
- Defined by
- Date Defined
- Criteria for Attribute

Test of the MCDM Model

A test of the TOPSIS model was conducted in Round 3 of the DHP survey. In this round, the MAJCOM representatives were given a sample set of 12 LNs selected from various levels of the 1989 priority list (Table VI).

First, using only the Brown Book description of the LNs (the previous year's ranking was marked-out) each participant was asked to prioritize the LNs by assigning each an ordinal rank from 1 to 12. This was very

Table VI. Data Set of Selected LNs.

1989 Rank	LN #	Title
01	83046	Chemical Protective Suit
02	89045	Bulk Fuel Storage Bladder Tank
03	87128	Fast Field Repair of Composite Structures
05	85009	Standardized Power Supplies
39	89085	Artic Communications Trailer/Pod and Antenna
40	87070	Robotic Welding/Inspection System
42	89043	Flightline Checks for Laser Designator/Ranger
43	88084	C-130 Flush Mount Antenna
71	89031	N-1 Compass Systems Amplifier Replacement
72	82047	Maintenance of Advanced/Next Generation Fan Stage Configuration
73	87033	Database for High-Pressure Underground Pipe
79	84011	Aircrew Training Devices Deployment Concept

similar to their work on the MAJCOM Coordinating Committee.

Next, in the second part of Round 3, the participants scored each of the 12 LNs on the top seven factors identified in Rounds 1 and 2. Each participant was given

the option of choosing up to three additional factors for scoring in addition to the required seven. The TOPSIS algorithm was executed for each participant's set of scores in accordance with Hwang's guidance for using MADM models with group members selecting dissimilar sets of attributes (Hwang, 1987:293). Then the TOPSIS rankings for each individual were compared with their ordinal rankings from the first part of Round 3. Appendix F contains the scoring and data matrices for each decision maker, along with the results of the TOPSIS distance calculations.

Consistency of TOPSIS Model. In order to evaluate the value of the TOPSIS model for prioritizing LNs, it was necessary to test how closely the model's ranking compared with the decision makers' ordinal rankings. This consistency check was accomplished both within individual decision makers and across all decision makers.

Consistency Within Individuals. Having calculated the ordinal and TOPSIS rankings, each individual's results were plotted on a graph. Figure 14 shows an example of the comparison of one decision maker's ordinal and TOPSIS rankings (other decision maker's results are at Appendix F). When the two rankings correspond, the point lies on the 45 degree line. The error and standard deviation between the two rankings were calculated for each decision maker (Table VII). The standard deviation for the individual decision makers ranged from .46 to 1.07.

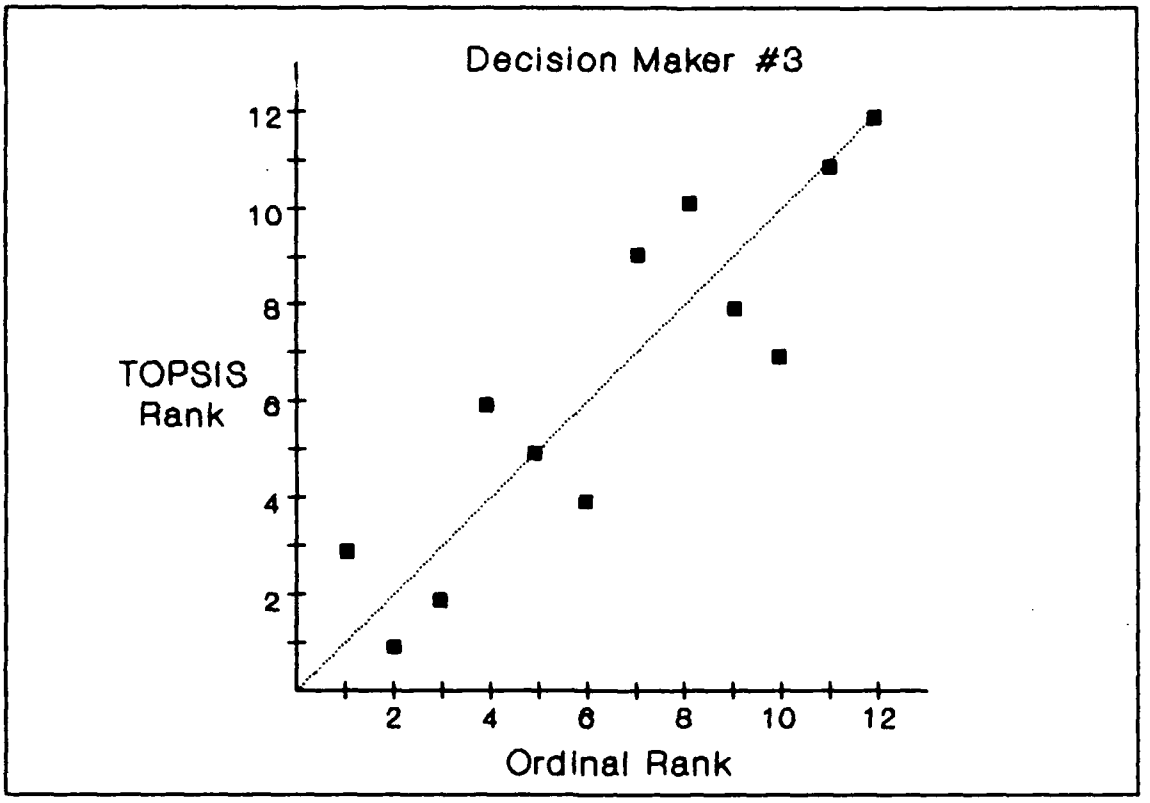


Figure 14. Comparing Decision Maker #3's Rankings

Table VII. Decision Maker #3's Rankings

LN #	Ordinal Rank	TOPSIS Rank	Error^2
83046	1	3	4.00
87128	2	1	1.00
89045	3	2	1.00
87070	4	6	4.00
85009	5	5	.00
89043	6	4	4.00
89031	7	9	4.00
89085	8	10	4.00
82047	9	8	1.00
88084	10	7	9.00
84011	11	11	.00
87033	12	12	.00
		Total SSE =	32.00
		Standard Dev =	.57

Consistency Across Individuals. A group ordinal ranking was calculated by averaging the individual ordinal rankings. Similarly, a group TOPSIS ranking was calculated by averaging the relative separation measures across all decision makers. Figure 15 shows the comparison of the two group rankings. As a group, the TOPSIS ranking corresponds very closely with the ordinal ranking. Table VIII summarizes the two group rankings and the error between them.

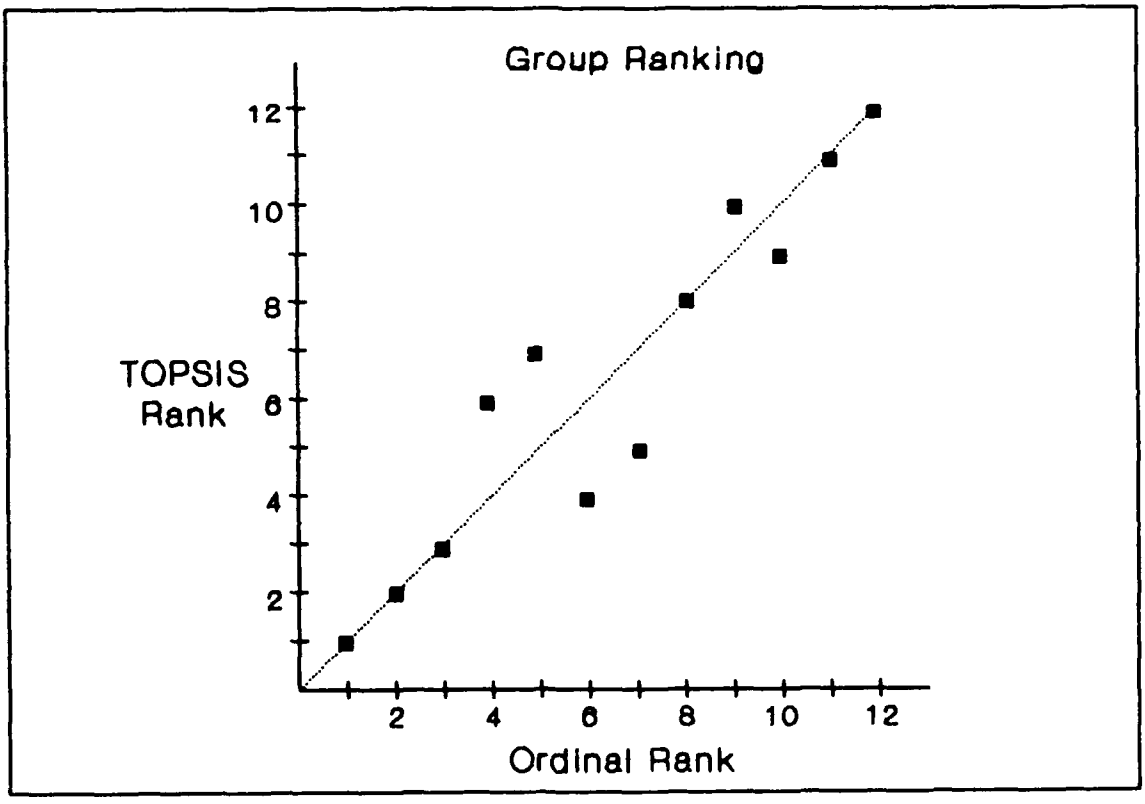


Figure 15. Comparing the Group Rankings

Table VIII. The Group Rankings

LN #	Ordinal Rank	TOPSIS Rank	Error^2
87128	1	1	.00
83046	2	2	.00
89045	3	3	.00
87070	4	6	4.00
89031	5	7	4.00
85009	6	4	4.00
89043	7	5	4.00
88084	8	8	.00
89085	9	10	1.00
82047	10	9	1.00
84011	11	11	.00
87033	12	12	.00
		Total SSE =	18.00
		Standard Dev =	.42

Design of a GDSS

As discussed in Chapter 3, a GDSS provides a framework for assisting with the various functions and steps of a decision process. The GDSS for the MAJCOM Coordinating Committee must support the functions of ranking LNs: obtaining information on LNs, discussing the LNs with other committee members, combining the knowledge on a set of attributes, and prioritizing the LNs with an analytical algorithm.

Storyboards. The storyboards depicting the screen representations of the kernel GDSS contain provisions for each of the important functions (Appendix G). The system progresses orderly (if desired, or the user can jump around

throughout the system) through the Main functions shown on the Home Screen and available throughout the system (Fig 16). Information concerning any LN can be viewed in a graphical, informative format. Lists of LNs can be examined: LNs within a Technology Area, those sponsored by a specific MAJCOM, etc. Communication features are available so that every user can communicate with each other, both known and anonymously. Each user has access to a public display, being able to send group messages and even project their entire screen image onto the public screen so all can see the information.

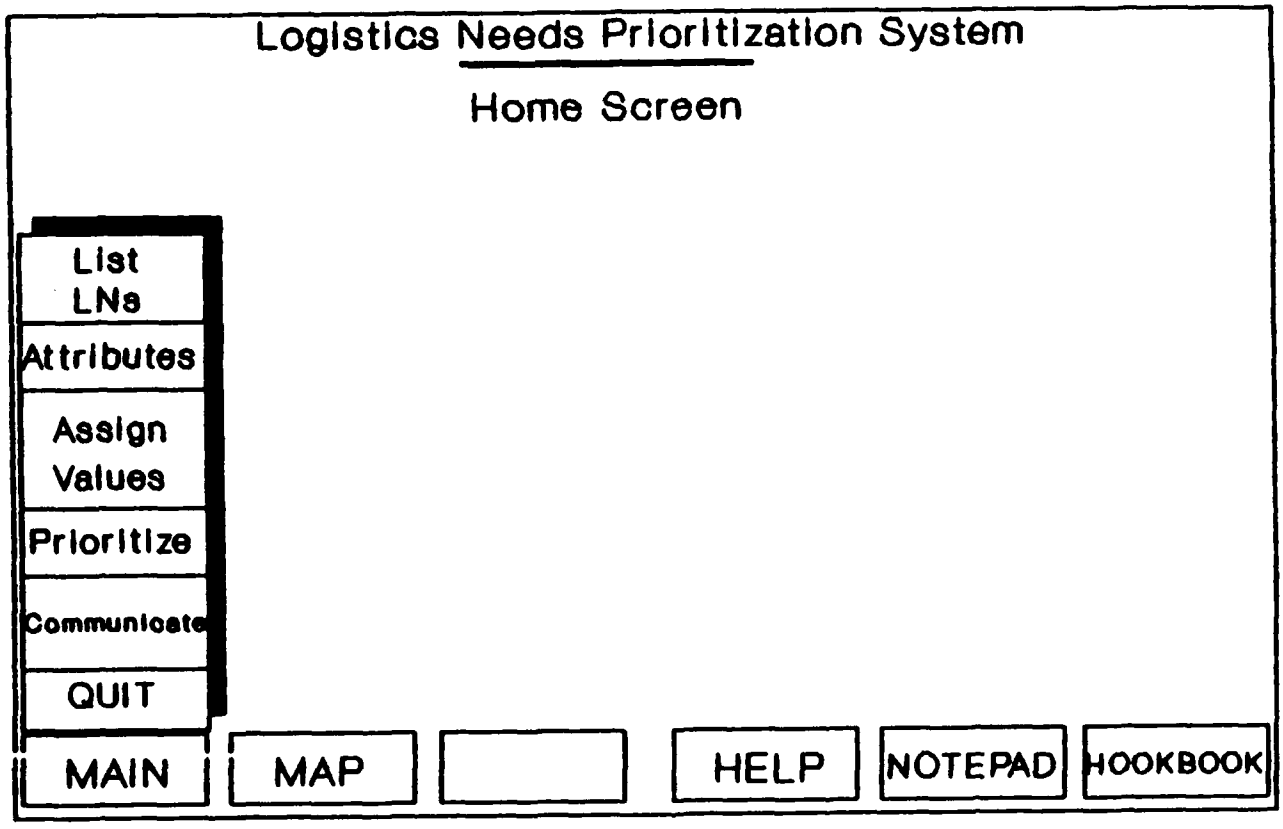


Figure 16. Kernel System Home Screen

The MCDM model is an integral part of the kernel system. Attributes can be defined and weighted and then values assigned to LNs based upon those attributes. Having gathered the necessary knowledge, the decision makers progress through scoring the LNs. They can opt to start with a previous set of scored LNs, or can start from scratch. This parallels the option for "folding-in" the newly submitted LNs to a previous list.

After each LN has been scored, the TOPSIS model uses the attribute weights and scores, calculates the rankings, and shows both a graphical display of the LNs relative to an ideal and negative-ideal point and also a more standard list of LNs in priority order. The graphical display can be used to observe groupings of LNs which could be further evaluated.

Roadmap to GDSS

Transitioning from a manual, paper-and-pencil decision process to implementing a fully-functional GDSS does not happen in one step, but rather gradually evolves. As Figure 17 indicates, the transition from the MAJCOM Coordinating Committee's current decision methods to implementing a GDSS would occur in three phases.

In the first phase, leading to a Management Information System (MIS), AFOLTA and the intended GDSS users must make decisions relating to the information requirements

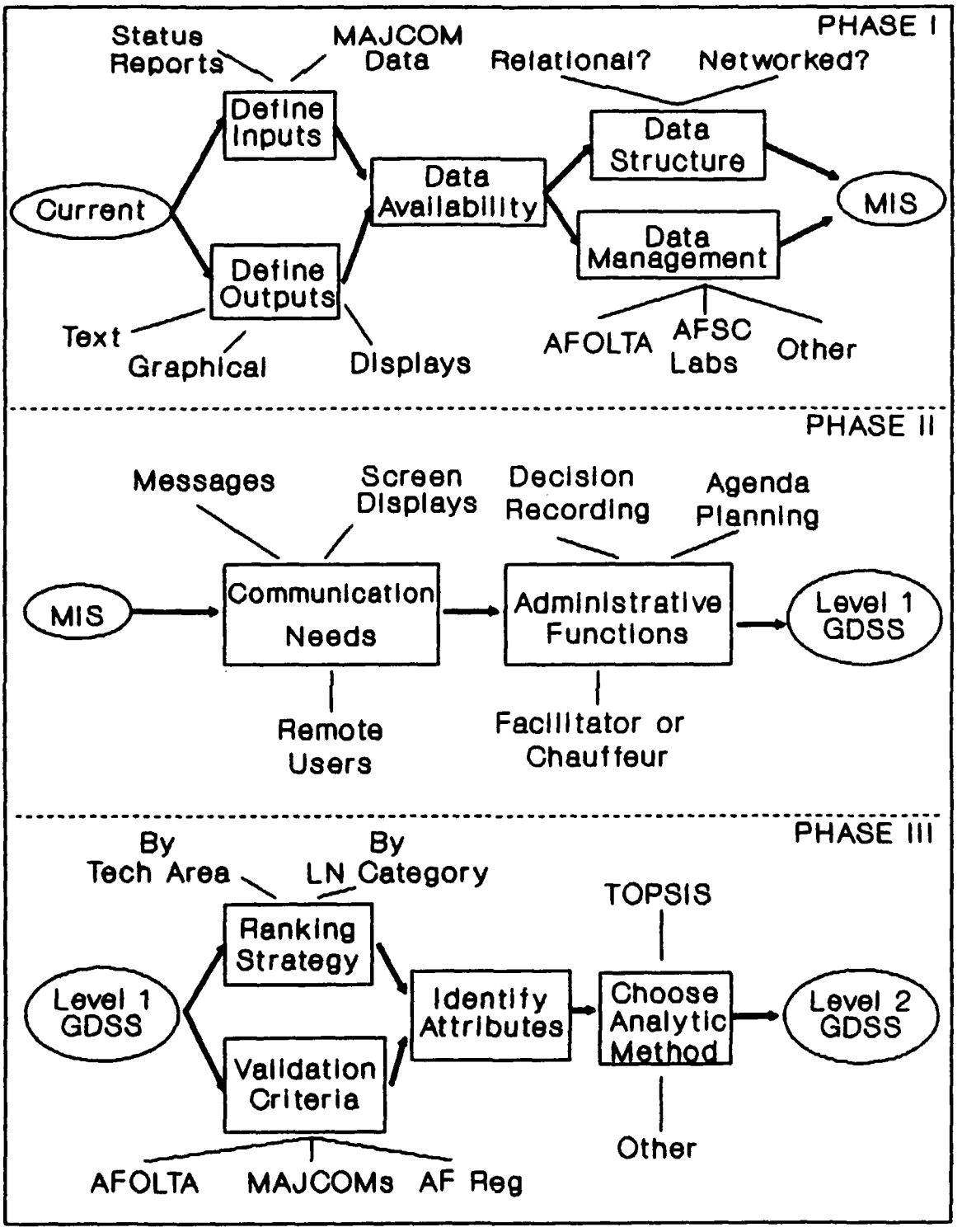


Figure 17. Roadmap to Implementing a GDSS

for prioritizing LNs. Then decisions concerning data requirements, availability, presentation, management, validation, and structure must be addressed. Each component feeding and defining the requirements and limits of the next. These decisions would establish the formal requirements for an MIS.

Phase II adds upon the MIS by including functions for group members to interact and for the recording of decision logic and justification. Additionally the nature of the committee session would be determined. A facilitator-directed environment could be chosen where the facilitator governs the discussion and decision process. Conversely, a chauffeured environment could be chosen where the chauffeur merely assists the group work through their decision process in any manner they choose. The results of these decisions provide a Level 1 GDSS to the MAJCOM Coordinating Committee.

The third phase of implementation adds the analytical support necessary in LN prioritization decision process. Here the decision of how to prioritize LNs would need to be made: ranking by Technology Area or by LN Category. Depending on that decision, appropriate attributes for evaluating LNs would be selected, and a scoring method established. The actual ranking algorithm would be implemented in this phase. At the conclusion of these decisions, a GDSS which contains all the components for ranking LNs would be in place.

Summary

The research agenda presented in this and the previous chapters has resulted in the design of a kernel GDSS for prioritizing LNs. Results of the research also established a useful set of criteria for ranking the LNs, showed the applicability of an MCDM model to the prioritization problem, defined the qualifications for representatives to the MAJCOM Coordinating Committee, and generally evaluated the LN identification process. The following chapter will address the conclusions of the research and provide recommendations.

V. Conclusions and Recommendations

This chapter presents the conclusions of the research, provides recommendations for action within the LN Program, and suggests areas for further research.

Conclusions

The LN Program. As discussed in Chapter 1, the primary purpose of the Air Force LN Program is to identify Air Force logistics research and development requirements. The overall LN identification program appears to be well-established and administered. Three new Air Force regulations institutionalize the identification process. Although these regulations thoroughly define the responsibilities and functions of the participating organizations in the LN Program, they are vague concerning validating, prioritizing, monitoring, tracking, and reporting the LNs. These functions are mostly left to AFOLTA's discretion.

Identifying LNs is a continual process, yet the current program limits this to an annual event, beginning with USAF/LE's "annual call" for submissions. AFOLTA does allow an occasional "out-of-cycle" LN submission, but the majority of new LNs are received during the annual submission time (Nenninger, 1989). Several of the MAJCOM LGs responding to the survey commented that they felt increasing the frequency of submissions, eliminating the time-constraint involved in

the current annual cycle, would increase the quality and significance of submissions.

LN Prioritization Process. The current process for prioritizing LNs meets the annual requirement for producing a rank-ordered list of LNs to publish in the Brown Book. The process is hindered by the lack of critical LN information for the decision makers, the absence of a defined set of criteria for evaluating the LNs, and an ordinal ranking structure which requires the decision makers to compare LNs directly against each other.

MAJCOM Representative Qualifications. The results of the LG survey indicated that the ideal representative to the MAJCOM Coordinating Committee is a logistics "generalist," having expertise in several areas relating to the LN program. Expertise should be the deciding factor in selecting a representative, not necessarily rank. All the LGs felt that their representative to the MAJCOM Coordinating Committee had the needed experience to be an effective MAJCOM spokesman.

LN Information. There is a vast amount of information that the MAJCOM Coordinating Committee members desired to have, most of which is not in the LN Database or currently available to them. In some instances the information exists, but has not been included in the database. AFOLTA recently required each sponsor to expand their justification and cost/benefit analysis (Potter, 1990). AFR 80-33 requires

AFSC to provide AFOLTA an annual status report on each LN. AFSC also reports annually on technology development and application efforts to satisfy LNs.

LN Database. The LN database, although limited in the amount of analytically descriptive information it contains, is functionally sound and easily accessed. The recent improvement which allows all users access to the database greatly increases the users' access to LN information. While BASIS is an effective environment for textual data such as the LN database, it is limited in its relational capability. This is not an immediate problem, but becomes more important as decision makers try to use the database to support their decision process. Additionally, the current large, flat-file approach to the LN database does not offer the flexibility that would be required as decision makers seek to extract critical information, often in several ways and combinations.

TOPSIS Application. The consistency of the TOPSIS ranking with the ordinal ranking was fairly good for each individual decision maker. The model parallels the decision maker priorities with only slight deviations.

Most striking are the group results. The individual inconsistencies are smoothed in the group rankings; the group results are more consistent than even the best individual results. The group result is particularly consistent at the extremes; the group identified the high

and low ranking LNs with almost perfect consistency. Even the small inconsistency in the middle LNs is significantly better than that of the individual results.

The TOPSIS test indicates that the MAJCOM representatives responding the DHP survey identified a set of attributes which fairly accurately captures their ranking criteria, and have relatively accurately translated the available data into scores on those attributes. With such a small number of LNs it was relatively simple to provide an ordinal ranking. With a larger set of LNs, such accuracy could not be expected. Thus the benefit of a methodology such as TOPSIS.

Recommendations

Implement an LN Management Information System. The LN prioritization process needs the support of a Management Information system (MIS) tied to expanded, improved databases.

LN Information. The key to making a good decision is having access to the right information and correctly understanding that information. AFOLTA needs to increase the amount of "analytical" information in the LN Database. This information would support the attributes the decision makers identified as critical to prioritizing LNs.

The submitting MAJCOMs could expand the way they describe the impact an LN would have on their operations, the

perceived impact on reliability and maintainability, and the potential to affect safety. Even if the MAJCOMs submitted a nominal indication (1 to 10, or Hi-Med-Low) of the LN's impact in each area along with a written justification, it would greatly expand the ability to explain the value of the LN to other MAJCOM representatives.

AFSC's annual LN status reports could be expanded to include specific estimates and judgements. The laboratory responsible for analyzing an LN could include an assessment of the development and implementation costs, the development time-frame, and the probability of eventually meeting the need.

Database Structure. The large LN Database should be converted to a relational environment in order to support the data browsing needs of the MAJCOM Coordinating Committee members. Several networked databases maintained by the appropriate offices would reduce AFOLTA's database administration tasks and also provide more LN information to the users.

Information Presentation. To fully provide understanding of the LN data, graphical presentations in addition to textual reports would be needed in the MIS.

Prioritize LNs by Technology Area. As a solution to the problems associated with ranking large lists of items, the LNs could be prioritized by Technology Area rather than by LN classification. AFOLTA already assigns each LN to one of the

Technology Areas, so classifying an LN would not be a new requirement. Of the 25 Technology Areas, the largest contains only 28 LNs while most have 10 or fewer.

Prioritizing by Technology Area would allow the committee members to do more comparing of "apples to apples." The LNs within a given Technology Area would have common elements and would be more easily compared for relative value. Criteria for determining the relative value would still have to be identified, however, but could be more specific than those for the set of all LNs.

An additional benefit to prioritizing by Technology Area is that it aligns the prioritization effort with the eventual use of the rankings by AFSC and other R&D organizations. AFSC divides its research budget and structures its R&D laboratories based on Technology Areas (Harshberger, 1990). AFSC currently uses the extracted lists of LNs prioritized within Technology Area which were taken from the overall list. As discussed above, extracts from large lists may not accurately portray the true priority order for the LNs, particularly below the top 10 or 20 LNs. Therefore, the lists prioritized by Technology Area would more accurately reflect the rankings than lists extracted from an overall ranking.

Prioritizing LNs by Technology Area implies the requirement to also prioritize the Technology Areas. This would be done to transmit MAJCOM preferences to AFSC for

consideration as they plan their R&D budgets.

Apply a MCDM Model. The current ordinal ranking process requires the decision makers to compare one LN directly to another. In doing so the decision makers rely on an undefined set of factors for making the comparisons.

Using this research as a foundation, AFOLTA should direct the MAJCOM Coordinating Committee to approve a set of attributes for prioritizing LNs. The LNs would be scored on the attributes and these scores used in a MADM model such as TOPSIS.

Such action increases the defendability of the priority order, since all scores and actions are measurable and recorded in the system. The MADM model also improves the accuracy of the rank order, particularly in the hard-to-determine middle-ranked LNs.

Implement a GDSS. Using the storyboards as a framework for an operational GDSS, AFOLTA should proceed through the three phases outlined in the roadmap and develop an operational GDSS for prioritizing LNs. The GDSS would incorporate all of the above recommendations. Such a GDSS would assist the decision making process by including functions for information presentation, communication, attribute definition and scoring, and prioritizing the LNs. The GDSS also helps structure the decision process, while still allowing each decision maker the freedom to complete the decision task according to his own desires and style.

Areas for Further Research

Technology Area Attributes. This research, focusing on the current decision process, identified the attributes for prioritizing LNs by LN Category. Changing to prioritizing by Technology Area would require the evaluation of attributes applicable to each Technology Area. Results of this analysis may redefine the Technology Areas, combining some and decomposing others according to their attributes. Also to be addressed would be specific criteria for assigning an LN to its appropriate Technology Area.

Building the Designed GDSS. Using this research as a foundation, build the GDSS using principles of adaptive design. A thorough analysis of hardware requirements, model and data interactions, user interfaces, and processing requirements would be a part of the development effort.

Effects of LN Priority on R&D Budgeting and Action. AFOLTA has conducted partial analyses on the LN R&D efforts relative to the priority assigned by the MAJCOM Coordinating Committee. The design of a method for tracking technology developments influenced by the LN Program and the development of some type of estimator for LN success would provide valuable information for ranking LNs.

Availability of LN-related Information. While AFOLTA maintains their LN Database, AFSC and other Air Force and industry agencies have databases which relate to LNs and LN technology development. This effort would catalog the

available R&D databases, noting their structure and accessibility. Results of this research could lead to the development of a R&D information management/coordination plan for the Air Force.

Summary

Through this research the LN prioritization decision process was analyzed and a GDSS was designed to support that process. Prioritizing LNs is a complex group decision problem characterized by uncertainty and a lack of critical information. The LN prioritization effort can be strengthened and improved by employing the recommendations of this research. By following the steps of the three phases described in the roadmap, a gradual transition can be made from the current, manual decision process to that using the designed GDSS.

This research can be applied to other group decision problems. The requirements and functions of a GDSS specific to the decision would be analyzed through a process similar to that conducted in this research. The roadmap developed in this research could be generalized to describe the implementation plan for any GDSS application.

Groups and individuals will continue to be faced with decision problems involving great amounts of uncertainty and complexity. Applying the concepts and methods described in this research to those decision problems can help the decision makers to make better decisions.

Bibliography

Ackoff, Russell L. "Management MisInformation Systems," Management Science 14 No. 4: 147-156, Dec 1967.

Adizes, Ichak and Efraim Turban. "An Innovative Approach to Group Decision Making," Personnel 62, No. 4: 45-49 (April 1985).

AFIT - Air Force Institute of Technology. Compendium of Authenticated Systems and Logistics Terms, Definitions,and Acronyms. AU-AFIT-LS-3-81, US Air Force Institute of Technology (AU), Wright Patterson AFB, OH, 1980.

AFOLTA - Air Force Office for Logistics Technology Applications. "Logistics Need Program." Unpublished briefing slides. Wright Patterson AFB, OH, March 1989.

Anderson, Larry. LN Database Administrator. Telephone interview. HQ ASD, Wright Patterson AFB, OH, 17 October 1989.

Andriole, Stephen J. (ed). Microcomputer Decision Support Systems: Design, Implementation, and Evaluation. Wellesly, MA: QED Information Sciences Inc., 1986.

Cook, Major Curtis R. A Study of Decision Making Processes in the Practice of Federal Contract Management. PhD dissertation. The George Washington University, Washington DC, July 1987.

Department of the Air Force. Air Force Combat Support Research and Development Requirements (Logistics Needs) Program. AFR 80-33 (draft). Washington DC: HQ USAF, November 1989.

Department of the Air Force. Air Force Logistics Management Center (AFLMC), Air Force Office for Logistics Technology Applications (AFOLTA). AFR 23-35 (draft). Washington DC: HQ USAF, November 1989.

Department of the Air Force. Logistics Board of Advisors (BOA). AFR 20-7 (draft). Washington DC: HQ USAF, November 1989

DeSanctis, Gerardine and Brent R. Gallupe. " A Foundation for the Study of Group Decision Support Systems." Management Science 33 No. 5: 589-609, May 1987.

Gerke, E. E. and E. M. Babb. "Analysis of Group Decision Making Using a Management Game." Organization and Management Sciences 8 No. 4: 77-83, Winter 1977/78

Gomez, L. David. LN Database Manager. Telephone interview. AFOLTA, Wright Patterson AFB, OH, 17 October 1989.

Gray, Paul. "Group Decision Support Systems." Oral presentation to ORSA/TIMS Conference, New York, Oct 1989.

Harshberger, Glenn. Branch chief, AFSC Combat Support Directorate. Telephone interview. HQ AFSC, Andrews AFB, VA, 2 February 1990.

Howard, Ronald A. and James E. Matheson. The Principles and Application of Decision Analysis, Volume I. Strategic Decisions Group, California, 1983.

Hwang, Ching-Lai and Kwangsun Yoon. Multi Attribute Decision Making Methods and Applications, A State-of-the-Art Survey. New York: Springer-Verlag, 1981.

Hwang, Ching-Lai and Ming-Jeng Lin. Group Decision Making Under Multiple Criteria: Methods and Applications. New York: Springer-Verlag, 1987.

Kersten, Gregory E. "NEGO -- Group Decision Support System." Information and Management (Netherlands) 8 No. 5: 237-246, May 1985.

Khorramshahgol, Reza and Vassilis S. Moustakis. "Delphic Heirarchy Process (DHP): A Methodology for Priority Setting derived from the Delphi Method and analytical Hierarchy Process." European Journal of Operations Research 37: 347-354, 1988.

Lewis, L. Floyd and Ken S. Kelanan. "Issues in Group Decision Support System (GDSS) Design." Journal of Information Science Principles and Practice (Netherlands) 14 No. 6: 347-354, 1988.

Long, Colonel Richard W. AFLC Reserve Forces Representative. Personal interview. HQ AFLC, Wright Patterson AFB, OH, 1 August 1989.

McFarren, Captain Michael. "Concept Mapping." Unpublished talking paper. School of Engineering, Air Force Institute of Technology (AU), Wright Patterson AFB, OH, 29 March 1987.

Moffitt, Kathleen E. "Computer Support for Group Decision Making: An Overview." Tempe, Arizona Technical Report #88-2, October 1988.

Nenninger, Mark. LN Manager. Personal interviews. AFOLTA, Wright Patterson AFB, OH, April 1989 - January 1990.

Nettleton, Captain Joseph B. B. Development of a Microcomputer-Based Expert Support System: Application of the Analytical Hierarchy Process to the Prioritization of Reliability and Maintainability Modifications. MS Thesis AFIT/GLM/LSY/88S-54. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright Patterson AFB, OH, September 1988.

Nunamaker, Jay, Doug Vogel, and Benn Konsynski. "Interaction of Task and Technology to Support Large Groups." Decision Support Systems 5 No. 2: 139-152, June 1989.

Pinsonneault, Alain and Kenneth L. Kraemer. "The Impact of Technological Support on Groups: An Assessment of the Emperical Research." Decision Support Systems 5 No. 2: 197-216, June 1989.

Potter, Lt Col Donald D. Chief, Logistics Management and Engineering Division. Personal interviews. AFOLTA, Wright Patterson AFB, OH, April 1989 - January 1990.

Rivchun, Sylvia. "Group Decision Making: Understanding the Not-So-Obvious Forces at Work," Association Management, Special Issue: 23-28, November 1978.

Small Business Commission. "Group Decision Making: Approaches to Problem Solving." Small Business Report 13 No. 7: 30-33, July 1988.

Simon, Herbert A. The Shape of Automation for Men and Management. New York: Harper & Row, Publishers, Inc., 1965.

Simon, Herbert A. et al. "Decision Making and Problem Solving," Interfaces, 17, No. 5: 11-31 (September-October 1987).

Sprague, Ralph H. Jr. and Eric D. Carlson. Building Effective Decision Support Systems. Englewood Cliffs, N.J.: Prentice Hall Inc., 1982.

Tatman, Major Jospeh A. "Decision Analysis -- MATH 5.70." Lecture notes. School of Engineering, Air Force Institute of Technology (AU), Wright Patterson AFB, OH, April - June 1989.

Usrey, Phil. Chief, Command Requirements Division. Personal interview. HQ AFLC, Wright Patterson AFB, OH, 3 August 1989.

Valusek, Lt Col John R. "Adaptive Design of DSSs: A User Perspective," DSS-88 Transactions, Eighth International Conference on DSS, 1988.

Vita

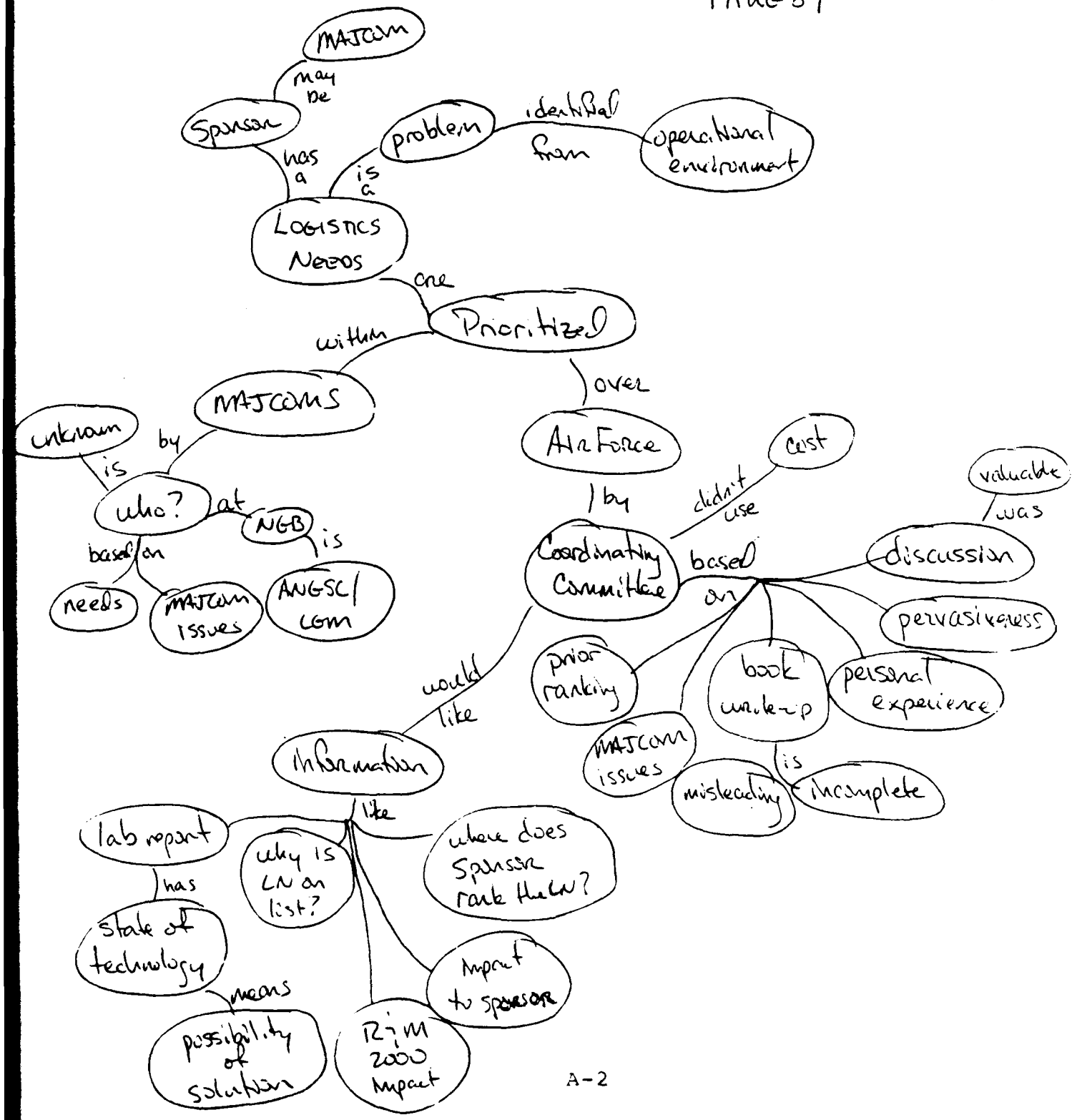
Captain Richard M. Schooff was born on 19 June 1960 at Ft. McClellan, Alabama. He graduated from General William Mitchell High School in Colorado Springs, Colorado and attended Brigham Young University. Interrupting his university studies, he served a two-year mission for the Church of Jesus Christ of Latter-Day Saints to Taiwan, ROC and maintains moderate fluency in Mandarin Chinese. He graduated from Brigham Young University in April 1984 with a Bachelor of Science in Mathematics, a commission in the USAF through the ROTC program, and the honor of Distinguished Graduate. His first assignment was with the Joint Studies Group, Headquarters Tactical Air Command. He served at TAC until entering the School of Engineering, Air Force Institute of Technology, in August 1988. Captain Schooff is married to the former Sharon Lord and they have one daughter, Ashley.

Permanent Address: 12737 Forestdale Dr.
Omaha, NE 68123

Appendix A. Original Concept Maps

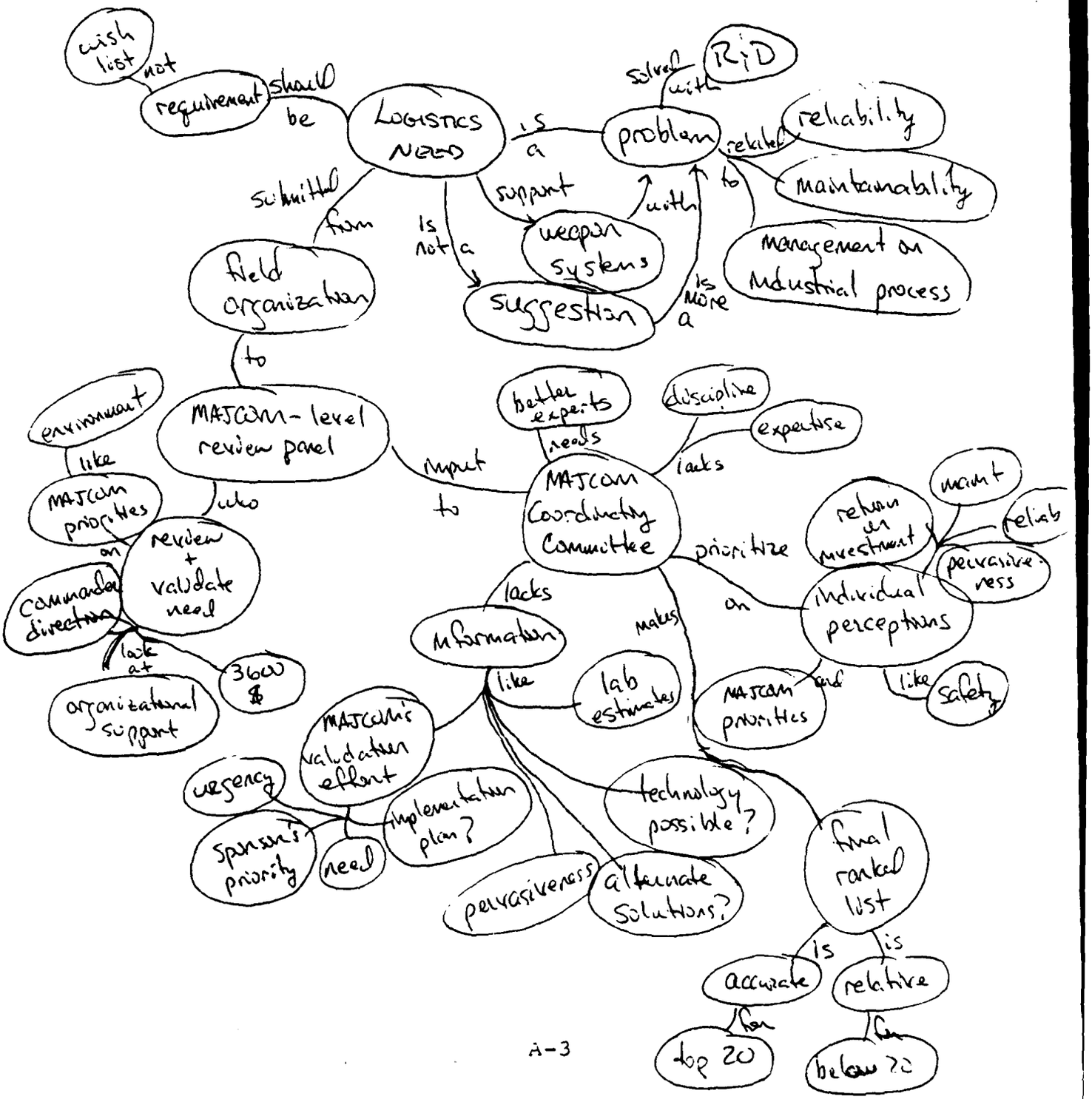
This appendix contains copies of the original concept maps which were used to understand and evaluate the decision process.

COL RICHARD LONG
AFLC/RF
1 AUG 89

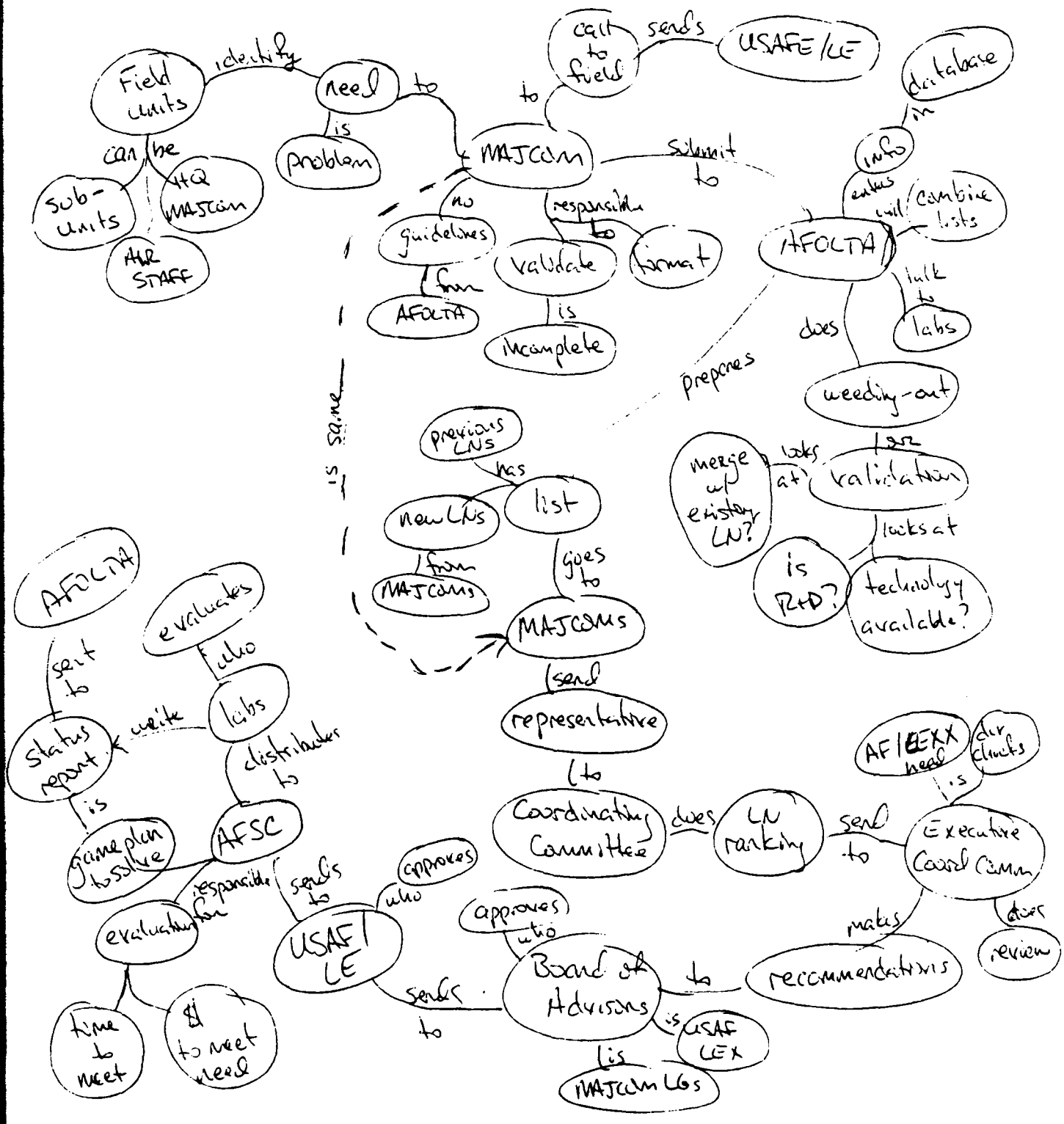


Mr. Phil Usrey
AFLC/XPRO

3 Aug 89



MARK NENNINGER
AFOLTA 7 NOV 89



Appendix B. Survey of MAJCOM LGs

This appendix contains a copy of the survey sent to the MAJCOM LGs who participate in the LN Program

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY
WRIGHT-PATTERSON AIR FORCE BASE OH 45433-6583

REPLY TO ATTN OF: Capt Schooff (AV785-7226/3030)
AFIT/ENA-4564

18 DEC 1989

SUBJECT: Logistics Needs Prioritization Research

TO: See Distribution List

1. One of our graduate students, Capt Richard Schooff, is analyzing the decision process involved in ranking Logistics Needs (LNs) as a part of his master's thesis. He needs your assistance in answering a few questions concerning your MAJCOM's participation in the LN process. Would you please take a few minutes and complete the attached questionnaire, returning it in the enclosed envelope by 8 Jan 1990. As we wish your answers to be honest and candid, all responses will be accorded a strict non-attribution policy towards both the author and MAJCOM.

2. As you are undoubtedly aware, prioritizing LNs is a rigorous, time-consuming task. Lack of critical information, the diversity of the LNs, and the uncertainties inherent with technology development further complicate the ranking effort. Working with minimal information, the representatives to the MAJCOM Coordinating Committee must be able to assess the relative importance not only of their MAJCOM-sponsored LNs, but also of those sponsored by other MAJCOMs.

3. Through his research, Capt Schooff is 1) designing a group decision support system (GDSS) which would support the information and analytical requirements of this ranking process, 2) preparing a roadmap of how the LN process can transition to a GDSS, and 3) has prepared, through a Delphi process, a model of key factors for ranking LNs. This survey, concerning the qualifications of the MAJCOM Coordinating Committee representatives, is the final piece of his research. A copy of his final thesis will be provided to you, if desired, upon completion (March 1990).

4. If you have questions or concerns about this research, please contact me at AV785-3362. Thank you for your assistance.

John R. Valusek

JOHN R. VALUSEK, Lt Col, USAF
Asst Professor of Operations Research
Department of Operational Sciences
School of Engineering

2 Atch
1. Distribution List
2. LN Questionnaire

Distribution List

HQ ATC/LG
Randolph AFB, TX 78150

HQ AFSPACECOM/LK
Peterson AFB, CO 80914

HQ AFRES/LG
Robins AFB, GA 31098

HQ NGB/LG
Washington DC, 20330

HQ SAC/LG
Offutt AFB, NE 68113

HQ AFCC/CC
Scott AFB, IL 62225

HQ AAC/LG
Elmendorf AFB, AK 99056

HQ TAC/LG
Langley AFB, VA 23665

HQ MAC/LG
Scott AFB, IL 62225

HQ PACAF/LG
Hickam AFB, HI 96853

HQ AFSC/PL/LG
Andrews AFB, MD 20334

HQ AFLC/XP/MM
Wright Patterson AFB, OH 45433

HQ USAFE/LG
APO NY 09012-5000

Logistics Need Program - MAJCOM Participation Issues
Questionnaire

Name _____ MAJCOM:_____

As a member of the Board of Advisors for the Air Force Logistics Needs Program, and as the director of logistics issues for your MAJCOM, your ideas concerning the LN Program and your MAJCOM's participation in the program are very important. Please take a few minutes to answer the following questions. It is your personal understanding and opinion of the LN process which is sought. Feel free to write directly on this questionnaire, or you can use a separate sheet of paper if desired.

Again, a strict policy of non-attribution is accorded your response towards both yourself and your MAJCOM.

---

1. MAJCOM LN Identification and Validation. In the LN identification process, each MAJCOM collects LN submissions from its headquarters and field units. Prior to forwarding these LNs to the Air Force Office for Logistics Technology Applications (AFOLTA), it is assumed that the MAJCOMs review, validate, and formalize these submissions.

(a) Does your MAJCOM have a formalized process for gathering and then validating the candidate LNs?

(b) Whether formalized or not, please describe your MAJCOM's current process of gathering and validating LNs.

(c) Are you satisfied with this process? Why or why not?

(d) Do you think other MAJCOM's processes are similar to, stronger than, or weaker than your MAJCOM's process?

2. Committee Representative. Your MAJCOM has a representative on the MAJCOM Coordinating Committee which prioritizes the LNs for the Air Force. AFOLTA requests that each MAJCOM send a colonel (or civilian equivalent) as their representative.

(a) Was your MAJCOM's representative to the 1989 Committee meeting a colonel (or equivalent)?

(b) Do you think this is a reasonable request? Why or why not?

(c) Does your MAJCOM have a specific individual or position designated to oversee LN issues for you MAJCOM? Was this person your representative? Why or why not?

3. MAJCOM Representative Expertise. Serving on the Board of Advisors, you must have expectations concerning the level of knowledge and expertise of those who generated the prioritized list of LNs you are asked to review.

(a) Regardless of rank, what background or expertise do you think is necessary in order to serve on the MAJCOM Coordinating Committee?

(b) Did your MAJCOM's representative meet the experience requirements you just listed? If not, what was your representative's background and expertise?

4. Meeting the Need. After the Board of Advisors and USAF/LE approve the prioritized list of LNs, it is published as the Air Force Logistics Research and Studies Program (commonly referred to as "the brown book"). This text is distributed to Air Force and industry research and development (R&D) organizations for consideration in planning their research agendas and budgets. Air Force Systems Command is responsible for evaluating the feasibility of accomplishing each LN and providing this assessment back to the originating agency through AFOLTA.

(a) In your MAJCOM's experience with the LN Program, are your logistics needs being met? Explain.

(b) Do you feel that your MAJCOM is receiving timely status reports concerning R&D efforts and technology development necessary to meet your requirements? If not, what type of report information would you like to have?

(c) Do you feel that the priority given an LN by the MAJCOM Coordinating Committee affects the R&D efforts for solving the particular LN? Explain.

5. Comments. Do you have any other comments or ideas about the LN Program or how your MAJCOM participates in the program?

Appendix C. DHP Survey Round 1

This appendix contains a copy of the Round 1 portion of the DHP survey sent to the members of the MAJCOM Coordinating Committee.

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY
WRIGHT-PATTERSON AIR FORCE BASE OH 45433-6583

LY TO
N OF:

Capt Richard M. Schooff (AV785-7226/3030)
AFIT/ENA-4564
WrightPatterson AFB, OH 45433

12 OCT 1989

JECT:

Logistics Needs Prioritization Research

TO: See Distribution List

1. For my AFIT master's thesis, I am analyzing the decision process involved in ranking Logistics Needs (LNs). I need your assistance to help identify some critical factors in the prioritization effort. Would you please take a few minutes and complete the attached questionnaire. I would appreciate it if you could return your completed form by 27 Oct 1989. A pre-addressed return envelope is enclosed.

2. As you are personally aware, prioritizing LNs is a rigorous, time-consuming task. Lack of critical information, the diversity of the LNs, and the uncertainties inherent with technology development further complicate the ranking effort. Through my research, I hope to enumerate key factors which would assist the LN participants more easily determine the relative importance of a given LN. From this starting point I want to prepare a roadmap plan for implementing a decision support system that would support the ranking process. A copy of the final thesis including recommendations and the roadmap will be provided to you, if desired, upon completion (March 1990).

3. I would ask for your assistance in participating in a Delphi-like survey.

a. This first questionnaire is an initial request for the factors which indicate a LN's priority. You are asked to: 1) list those factors you considered -- or feel should be considered -- when ranking LNs; 2) provide a short justification for each factor; and 3) weight each factor to indicate its relative importance.

b. After receiving responses from the first questionnaire, I will compile the responses and send a second questionnaire. The purpose of the second round is to provide overall information about the factors and their weights and allow you to again weight the factors in light of this information.

c. A third and final questionnaire will then be sent. The third round questionnaire will ask you to perform pairwise comparisons between the most important factors. This information will be used to establish a hierarchy of decision factors.

4. Identifying the critical factors and their weights will be a big step in better describing and understanding the LN ranking process. Knowing these factors will also help define the information requirements necessary to support the decision process. If you have any questions or concerns about this research, please contact my thesis advisor, Lt Col Valusek, at AV785-3362. Thank you for your assistance.

R M. Schooff

RICHARD M. SCHOOFF, Captain, USAF
AFIT Graduate Student

C-2

1. Distribution List
2. Questionnaire #1

Distribution List

Col Kent Carlson
ASD/YCK
Wright Patterson AFB, OH 45433

Col Ronald L. Davidson
HQ 2163rd CG/CC
Peterson AFB, CO 80914-6346

Col Jonathan L. Greenburg
HQ AFRES/LGX
Robins AFB, GA 31098

Col Dick Long
HQ AFLC/RF
Wright Patterson AFB, OH 45433

Col Jack O. Miller
HQ SAC/LGX
Offutt AFB, NE 68113

Col Gary C. Ross
HQ AFCC/LGX
Scott AFB, IL 62225

Capt Rob VanGorder
HQ TAC/IGIM
Langley AFB, VA 23665

LtCol Richard Lasher
HQ AAC/LGX
Elmendorf AFB, AK 99056

Capt Paul Schmonsees
HQ MAC/LGR
Scott AFB, IL 62225

Capt Nolan Singer
HQ PACAF/LG
Hickam AFB, HI 96853

Mr. Ben Fullen
HQ AFSC/PLX
Andrews AFB, MD 20334

Mr. Phil Usrey
HQ AFLC/XPRO
Wright Patterson AFB, OH 45433

Ms JoAnn West
HQ USAFE/LGXI
APO NY 09012-5000

Factors In Ranking Logistics Needs
Questionnaire #1

Name: _____

Part I

As a member of the committee to rank Logistics Needs, you have experienced the task of determining the relative importance of LNs. In the space provided, please name at least five factors (space for ten is given) that you considered -- or feel should be considered -- when ranking LNs. Indicate whether you actually considered the factor or not in your own ranking process. Also, for each factor write a one or two-sentence justification for that factor. Please be very specific and do not be concerned whether the factors are measurable or if data is available to support the factors.

Example: Factor: Pervasiveness
Justification: The extent of a LN (is it an Air Force-wide concern or just one MAJCOM's concern?) affects its priority. Additionally, does the LN impact several or only a few weapon systems?

---

1. Factor:

   Justification:

2. Factor:

   Justification:

3. Factor:

   Justification:

4. Factor:

   Justification:

5. Factor:

   Justification:

Part I (cont)

6. Factor:

   Justification:

7. Factor:

   Justification:

8. Factor:

   Justification:

9. Factor:

   Justification:

10. Factor:

    Justification:

Part II

Using your answers in Part I, rank the factors in order of importance, from most to least important. Weight these objectives using a scale of 1 to 100. Assign 100 to the objective you consider most important, and judge all others by that objective. One almost as important might be 95; half as important would be 50.

Rank Ordered Factors	Relative Weight
1.	100
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

Appendix D. DHP Survey Round 2

This appendix contains a copy of the Round 2 portion of the DHP survey sent to the members of the MAJCOM Coordinating Committee.

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY
WRIGHT-PATTERSON AIR FORCE BASE OH 45433-6583

REPLY TO ATTN OF: Capt Richard M. Schooff (AV785-7226/3030) 5 Dec 1989
AFIT/ENA-4564
SUBJECT: Wright Patterson AFB, OH 45433

Logistics Needs Prioritization Research

TO:
See Distribution List

1. Thank you for your response to the first questionnaire. I have compiled the results from all respondents and have prepared the second round of the survey. Would you please take a few minutes a complete the attached questionnaire (Atch 2). If you did not complete the previous questionnaire, you are still invited to participate this time. I would appreciate it if you would return your completed form by 22 Dec 1989. The response time may appear short, but you should find that completing this round's questionnaire is significantly easier than the first.

2. a. In this round you have the information from all Round One responses. You are asked to re-weight the LN factors in light of this information. As noted in the Round One Summary Results (Atch 3), responses to Round One produced a rich list of factors considered important to LN prioritization. The 9 decision makers identified 20 distinct attributes. Eleven of the attributes were identified by more than one decision maker and seven of these were mentioned by four or more respondents.

b. The final weight assigned to each attribute was calculated based on two factors: 1) the average weight for an attribute, and 2) the percentage of participants favoring it. The reason for considering the two factors is to reduce the weight for an attribute that may have a high weight but may not be highly favored (consider the case where an attribute weighs 100 but is chosen by only one participant; in other words, all participants but one think it should not be considered for further analysis).

3. Your original Questionnaire #1 is enclosed to help you recall your responses. Several respondents mentioned similar factors with only semantic differences. As facilitator of this Delphi survey, I combined some factors and further defined others (see definitions - Atch 4). You will note my comments on your original form explaining any changes I may have made. If you do not agree with these changes, feel free to make comments on Questionnaire #2.

5. If you have questions or concerns about this research, please contact me or my thesis advisor, Lt Col Valusek, at AV785-3362. Thank you for your assistance.

RICHARD M. SCHOOFF, Captain, USAF
AFIT Graduate Student

4 Atch
1. Distribution List
2. Questionnaire #2
Round One Summary Report
Factor Definition

Distribution List

Col Kent Carlson
ASD/YCK
Wright Patterson AFB, OH 45433

Col Ronald L. Davidson
HQ 2163rd CG/CC
Peterson AFB, CO 80914-6346

Col Jonathan L. Greenburg
HQ AFRES/LGX
Robins AFB, GA 31098

Col Dick Long
HQ AFLC/RF
Wright Patterson AFB, OH 45433

Col Jack O. Miller
HQ SAC/LGX
Offutt AFB, NE 68113

Col Gary C. Ross
HQ AFCC/LGX
Scott AFB, IL 62225

LtCol Richard Lasher
HQ AAC/LGX
Elmendorf AFB, AK 99056

Capt Rob VanGorder
HQ TAC/IGIM
Langley AFB, VA 23665

Capt Paul Schmonsees
HQ MAC/LGR
Scott AFB, IL 62225

Capt Nolan Singer
HQ PACAF/LG
Hickam AFB, HI 96853

Mr. Ben Fullen
HQ AFSC/PLX
Andrews AFB, MD 20334

Mr. Phil Usrey
HQ AFLC/XPRO
Wright Patterson AFB, OH 45433

Ms JoAnn West
HQ USAFE/LGXI
APO NY 09012-5000

Factors In Ranking Logistics Needs
Questionnaire #2

Name: _____

The following is a summary of the responses to the recent questionnaire on factors for LN prioritization. They were scored based on the average weight and the number of respondents favoring each factor.

Please take a few minutes to review the summary, and weight the factors using a scale of 1 to 100. Assign 100 to the objective you consider most important, and judge all others by that objective. One almost as important might be 95; half as important would be 50; a factor you think should not be considered would be 0. Remember that the current ordering shown is merely a compilation of initial responses; your ordering of these factors will most likely not match the printed order.

Factor	Weights from Round 1	New Weight
1. Pervasiveness	71.11	_____
2. Mission Requirement/Impact	58.33	_____
3. Feasibility/Prob Tech. Success	46.67	_____
4. Payback	38.89	_____
5. Cost to develop/implement	28.89	_____
6. Reliability & Maintainability	28.33	_____
7. Command Interest	26.11	_____
8. Safety	18.89	_____
9. Probability of Funding	17.78	_____
10. Threat Environment	17.22	_____
11. Timeliness	14.44	_____
12. Significance to Originator	11.11	_____
13. Consistency w/ AF goals, etc.	8.33	_____
14. Actual "need" vs "want"	7.78	_____
15. Application - now or later	5.56	_____
16. Effectiveness	4.44	_____
17. Usability	4.44	_____
18. Spin-off	3.89	_____
19. Work Arounds	2.22	_____
20. Life Expectancy of Item	1.11	_____

Round One
Attributes and Weights
Summary Results

Attribute	Decision Maker 1	2	3	4	5	6	7	8	9	Avg Weight	% of DM Favoring Atrib	Final Weight
Pervasiveness	90	100		70	40	90	100	50	100	80.00	88.89	71.11
Mission Requirement/Impact	30		100	70		50	95	100	80	75.00	77.78	58.33
Feasibility/Tech Success	80			50	100	80	80		30	70.00	66.67	46.67
Payback	50			70		100		60	70	70.00	55.56	38.89
Cost to develop and implement		60	30		50			50	70	52.00	55.56	28.89
Reliability & Maintainability			80	70	35	70				63.75	44.44	28.33
Command Interest		30		20		60	50		75	47.00	55.56	26.11
Safety			70	100						85.00	22.22	18.89
Probability of Funding	70	90								80.00	22.22	17.78
Threat Environment		80			75					77.50	22.22	17.22
Timeliness	60	70								65.00	22.22	14.44
Significance to originator	100									100.00	11.11	11.11
Consistency w/ goals, obj.								75		75.00	11.11	8.33
Actual "need" vs "want"							70			70.00	11.11	7.78
Application - Now or later		50								50.00	11.11	5.56
Effectiveness	40									40.00	11.11	4.44
Useability		40								40.00	11.11	4.44
Spin-off	35									35.00	11.11	3.89
Work Arounds	20									20.00	11.11	2.22
Life Expectancy of Item					10					10.00	11.11	1.11

Factors in LN Prioritization
Explanation and Definition
(From Round 1 Questionnaire)

1. Pervasiveness - The extent to which an LN affects the entire Air Force versus a single command, several weapon systems versus only one. How wide is the need or application of the solution?

2. Mission Requirement/Impact - The impact on the operational mission: for example, impact on sortie rates. Does LN affects training, methods and procedures, equipment, or weapon systems? What is impact if LN is not fulfilled?

3. Feasibility/Probability of Technical Success - The availability of technology in the near future; the likelihood of solution in the near term; the level of effort in the labs. Is it still a theoretical concept in the laboratories or is it an existing technology ready for application? Is the LN realistic?

4. Payback - Dollar and manpower savings due to meeting the requirements of the LN.

5. Cost to Develop and Implement - Cost in absolute terms. Is cost of satisfying need reasonable? Will the R&D effort for this LN cost more than it will save?

6. Reliability & Maintainability - The extent to which the LN improves reliability/maintainability of the affected systems.

7. Command Interest - The level of applicability to my own MAJCOM. Is this particular LN significant to my MAJCOM?

8. Safety Impact - The degree to which the LN would prevent loss of life or loss of equipment. Solution to a flight or ground safety problem.

9. Probability of Funding - If technology were available to fulfill the LN requirements, with what degree of certainty would my MAJCOM provide funding to implement the LN? Can funding and tasking be obtained to support R&D for the need?

10. Threat Environment Impact - Degree to which the LN resolves or improves capabilities against a specific threat.

11. Timeliness - The length of time until technology is available to solve the LN.

12. Significance to Originator - The importance the originator (sponsor) places on the LN relative to all other LNs (overall, and of those sponsored by the originator). Where does the originator think the need falls in the overall scheme of his operations?

13. Consistency with Air Force Goals, Objectives, and Strategies - Extent to which the LN supports the Air Force directives and policy directions versus satisfying individual MAJCOM whims.

14. Actual "Need" versus "Want" - Degree to which the LN's solution will actually be used. Will it be used, or is it just a good idea?

15. Application: Now or Later? - Is this a LN to resolve a problem with currently fielded weapon systems or a forseen deficiency for future systems?

16. Effectiveness - How well the solution actually solves the need. Is solution complete and effective, or merely a step towards final resolution?

17. Usability - The degree to which the LN resolution will be war friendly, easy to operate, reliable and maintainable.

18. Spin-Off - Breadth of application of the LN solution beyond the original need. Does the technology needed to resolve the LN have a broader application?

19. Work Arounds - Number and potential for other solutions to solve LN. Are there other ways of meeting need?

20. Life Expectancy of Item - Length of time an item will be in the inventory.

Appendix E. DHP Survey Round 3

This appendix contains a copy of the Round 3 portion of the DHP survey sent to the members of the MAJCOM Coordinating Committee.

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY
WRIGHT-PATTERSON AIR FORCE BASE OH 45433-6583

REPLY TO ATTN OF:

Capt Richard M. Schooff (AV785-3030)
AFIT/ENA-4564
Wright Patterson AFB, OH 45433

16 Jan 1990

SUBJECT:

Logistics Needs Prioritization Research

TO: See Distribution List

1. Thank you for your prompt response to the second round questionnaire. I have compiled the results from all respondents and have prepared the final round of the survey. Would you please complete the attached questionnaire (Atch 2), returning your completed forms by 2 Feb 1990.

2. a. In this round you are presented with 12 Logistics Needs from the "Brown Book." Using their book description, you are asked to prioritize these LNs as you did when meeting with the MAJCOM Coordinating Committee. Next you are given a scoresheet for each LN. Using the book description and your understanding of the LN, you are asked to score each LN by assigning values to the attributes which were identified in the Round One and Round Two surveys. I will calculate and compare the two different rankings.

b. As you will undoubtedly notice when completing this survey, the task of scoring each LN relies on your subjective assessment of the LN attribute values. This is an important issue in ranking LNs -- the need for objective data (or even expert opinion) to supplement the book description. Some such data is available, but has not been collected or made available for use in the ranking process. Without this objective data, your subjective assessment of the LN becomes the "expert opinion."

3. I thank you for your participation in this Delphi survey. Your efforts and insights have greatly assisted my research. A copy of the thesis will be provided to you upon its completion. If you have questions or concerns about this research, please contact me or my thesis advisor, Lt Col Valusek, at AV785-3362. Thank you for your assistance.

RICHARD M. SCHOOFF, Captain, USAF
AFIT Graduate Student

4 Atch
1. Distribution List
2. Questionnaire #3

Distribution List

Col Kent Carlson
ASD/YCK
Wright Patterson AFB, OH 45433

Col Ronald L. Davidson
HQ 2163rd CG/CC
Peterson AFB, CO 80914-6346

Col Jonathan L. Greenburg
HQ AFRES/LGX
Robins AFB, GA 31098

Col Dick Long
HQ AFLC/RF
Wright Patterson AFB, OH 45433

Col Jack D. Miller
HQ SAC/LGX
Offutt AFB, NE 68113

Col Gary C. Ross
HQ AFCC/LGX
Scott AFB, IL 62225

LtCol Richard Lasher
HQ AAC/LGX
Elmendorf AFB, AK 99056

Capt Rob VanGorder
HQ TAC/IGIM
Langley AFB, VA 23665

Capt Paul Schmonsees
HQ MAC/LGR
Scott AFB, IL 62225

Capt Nolan Singer
HQ PACAF/LG
Hickam AFB, HI 96853

Mr. Ben Fullen
HQ AFSC/PLX
Andrews AFB, MD 20334

Maj William B. Garner
HQ AFLC/XPRO
Wright Patterson AFB, OH 45433

Ms JoAnn West
HQ USAFE/LGXI
APO NY 09012-5000

Ranking Logistics Needs
Questionnaire #3

PART I

Following are 12 LNs from the "Brown Book." Using the attached book descriptions, please rank them from 1 to 12. This should be very similar to your work on the MAJCOM Coordinating Committee.

Rank	LN #	Title
_____	82047	Maintenance of Advanced/Next Generation Fan Stage Configuration
_____	83046	Chemical Protective Suit
_____	84011	Aircrew Training Devices Deployment Concept
_____	85009	Standardized Power Supplies
_____	87033	Database for High-Pressure Underground Pipe
_____	87070	Robotic Welding/Inspection System
_____	87128	Fast Field Repair of Composite Structures
_____	88084	C-130 Flush Mount Antenna
_____	89031	N-1 Compass Systems Amplifier Replacement
_____	89043	Flightline Checks for Laser Designator/Ranger
_____	89045	Bulk Fuel Storage Bladder Tank
_____	89085	Artic Communications Trailer/Pod and Antenna

LOGISTICS DEVELOPMENT REQUIREMENT

LOGISTICS NEED NUMBER: 82047

TITLE:
Maintainability of Advanced/Next Generation Fan Stage Configurations

OBJECTIVE:
Develop guidelines to be used when choosing "BLISK" (Blade/Disk Combination) vs conventional fan stages when considering field supportability. Also, develop optimum repair procedures for these "BLISK" configurations.

PROBLEM:
Blade/disk combination fan stages are getting popular in small (500 lbs - 2500 lbs) engines and in certain advanced programs for large engines. The cost and supportability of these types of stages must be carefully examined to assure that, from a user's standpoint, they are affordable and provide for adequate field supportability.

RELATED EFFORTS:
Joint Technology Demonstration Engine (JTDE) uses a BLISK fan although this particular subject hasn't been addressed in detail.

DELIVERABLE REQUIREMENT:
A report that would provide a basis for rational supportability/maintainability decisions when considering BLISK fan stage designs and optimum BLISK repair procedures.

PAYOFF/BENEFIT:
Repair capabilities for new BLISK fan stage configurations.

LN CATEGORY/RANKING:

TECHNOLOGY AREA: Depot Maintenance

POINT(S)-OF-CONTACT:
Current Sponsor:
David Anderson, ASD/YZLE (AFSC), (513) 255-5853 (AV 785-5853)
Original Submitter:
David Anderson, ASD/YZLE (AFSC)
Co-Sponsor(s):
Don Mates, ASD/YZSL (AFSC), (513) 255-4574 (AV 785-2574)
MAJCOM LN Focal Point:
Ben Fullen, HQ AFSC/PLX, (301) 981-5528 (AV 858-5528)
AFOLTA LN Manager:
Paul Ankeney, AFOLTA/LQN, (513) 255-2241 (AV 785-2241)
Action Agency:
Jerry Cazzell, ASD/AFZXL, (513) 255-8335 (AV 785-8335)
Theodore G. Fecke, WRDC/POTC, (513) 255-2081 (AV 785-2081)

LOGISTICS DEVELOPMENT REQUIREMENT

LOGISTICS NEED NUMBER: 83046

TITLE:
Chemical Protective Suit

OBJECTIVE:
Field a Nuclear/Biological/Chemical (NBC) individual protective ensemble for aircraft maintenance personnel providing increased protection, endurance, comfort, and maneuverability for the performance of critical aircraft maintenance tasks in an NBC environment. (updated 5/89)

PROBLEM:
The current chemical defense ensemble has deficiencies which severely limit or degrade Air Force mission performance while operating in a contaminated environment. The major problems created by the current protective ensembles are: reduced mobility, poor visibility, poor communications, reduced dexterity, thermal stress, and lengthy decontamination processing. Furthermore, maintenance technicians must work more carefully (and slowly) while in the chemical ensemble to avoid action that might compromise (puncture, cut, tear) the suit. Many maintenance tasks are seriously degraded, and some are impossible to perform resulting in extended aircraft downtime. (updated 5/89)

RELATED EFFORTS:
LN 87042, Nuclear, Biological, and Chemical (NBC) Protection for Personnel
(1) USAF SON 004-85, Sustained Operations in a Chemical/Biological Environment (S NOFORN)
(2) TAF SORD (USAF 004-85)-I/II-C, Chemical/Biological Protective Garment (U)

REFERENCES:
1) ASD-TR-81-5003 Ground Crew Chemical Defense Equipment Performance Task Time Degradation. 2) AFHRL-TP-87-33, Effects of Chemical Warfare Defense on Airbase Maintenance Operations Phase II Report. 3) AFHRL-TP-87-42, Design Problems on Today's Aircraft. 4) AD-TR-85-7, A Performance Evaluation Using the Impermeable Chemical Defense Protective Ensemble and the Standard Chemical Defense Ensemble.

DELIVERABLE REQUIREMENT:
An individual NBC protective ensemble for aircraft maintenance technicians operating in a contaminated environment. The suit should provide increased dexterity and maneuverability, and reduced bulk to prevent entanglement on equipment and excessive suit shifting while performing physical tasks to sustain sortie generation. The ensemble should also provide: sufficient warmth to -40 degrees F without becoming brittle and ineffective, a cooling capability to prevent heat stress in temperatures to 100 degrees F, eye and respiratory protection that does not restrict the wearer's vision, a communications capability, rapid don/doff and decontamination processing, and increased fire and abrasion protection. (updated 5/89)

LOGISTICS DEVELOPMENT REQUIREMENT

LOGISTICS NEED NUMBER: 84011

TITLE:
Aircrew Training Devices (ATDs) Deployment Concept

OBJECTIVE:
Develop an improved method of tempest protection and housing for DOD-owned aircrew training device equipment, including Air Force category I, II, III and IV.

PROBLEM:
The present DOD methodology of TEMPEST protection and housing ATD equipment in fixed-site facilities will become less practical and more expensive in the coming years (the escalating cost of providing TEMPEST protection for the sophisticated computer systems and hardware associated with ATD requires judicious examination of alternate deployment concepts). The Air Force EF-111A Operational Flight Trainer (OFT) facility modification project has escalated from $900 thousand to $1.3 million cost. Recent developments call for a TEMPEST protection evaluation that has a potential for further increasing the facility cost $343 thousand to $686 thousand. The advantage of a transportable ATD housed in pre-packed modules (trailer-type vans) or NAVAIR shelters will be practical and cost effective in the decades to come.

RELATED EFFORTS:
A project to house A-10A Operational Flight Trainers in temporary pre-fabricated facilities was initiated by ASD/YWT/YWF, WPAFB OH, AV 785-7489.

REFERENCES:
British Ministry of Defence (MOD) and flight simulator personnel at RAF Honington, United Kingdom.

DELIVERABLE REQUIREMENT:
Report outlining benefits of pre-packaged modules for aircrew training devices with TEMPEST requirements.

PAYOFF/BENEFIT:
ATDs housed in pre-packaged modules (trailer-type vans) will be more cost effective during deployment due to the escalating cost of providing TEMPEST protection for the computer systems and associated hardware. Mobile facilities will also increase the protection of a valuable training resource.

LN CATEGORY/RANKING:

TECHNOLOGY AREA: Manpower/Training

LOGISTICS DEVELOPMENT REQUIREMENT

LOGISTICS NEED NUMBER: 85009

TITLE:
Standardized Power Supplies

OBJECTIVE:
Develop a set of standardized characteristics/parameters for current and future military power supplies which will incorporate reliability and maintainability data.

PROBLEM:
Historically, avionics system or subsystem designers have developed electrical power conditioners (power supplies) for every new design. The maturing process of design, test, fail, fix, test, etc. is repeated with attendant inefficiencies. Families of standardized power supplies must be identified and recorded for the designer to achieve a more standardized, higher reliable, easier maintainable, and lower life cycle cost power supply.

RELATED EFFORTS:
Power Supply R&M Improvement Program, PE 63743F

REFERENCES:
Office of the Secretary for Defense Institute for Defense Analysis Report "R&M Improvement Recommendations For 1984 Through 2000," dated Apr 83.

DELIVERABLE REQUIREMENT:
Generic data base categorizing characteristics/parameters (including R&M) of current fielded military power supplies of the DOD which could be updated as needed and used by system designers to achieve more standardized, reliable, and easily maintainable power supplies.

PAYOFF/BENEFIT:
Development of a generic data base for power supplies would aid the scientist/designer in choosing a reliable, maintainable and lov life cycle cost power supply off-the-shelf rather than design a totally new power supply.

LN CATEGORY/RANKING:

TECHNOLOGY AREA: Power Supplies

POINT(S)-OF-CONTACT:
Current Sponsor:
Philip Trickett, ALD/EREA (AFLC), (513) 255-3650 (AV 785-3650)
Original Submitter:
Philip Trickett, AFALC/EREA (AFLC)

LOGISTICS DEVELOPMENT REQUIREMENT

LOGISTICS NEED NUMBER: 87033

TITLE:
Design Data Base for High Pressure Underground Piping

OBJECTIVE:
Develop a design handbook for high pressure fluid distribution systems in support of daily flying operations.

PROBLEM:
There is no design data base for high pressure (4000 and 8000 psi nominal) underground piping to distribute hydraulic fluid to aircraft parked up to 2000 feet from the central equipment station. Were this database available, an aircraft hydraulic system fixed support design could be engineered and evaluated for inclusion in centralized aircraft support systems (CASS). CASS designs now provide 400 Hz and 60 Hz electricity, compressed air for engine starts, conditioned air, and liquid coolant. Substantial savings can be realized when mobile support equipment using petroleum fuels are replaced by CASS with commercial electricity powered industrial motor-generators, pumps, compressors, etc. Other benefits seen are reduced congestion hazards and noise in the vicinity of the aircraft and extended life on presently owned mobile support equipment (which can be dedicated to alert aircraft support and mobility/contingency operations). The high pressures are derived from aircraft designs; the B-1B hydraulic system demands 4000 psi at the aircraft/support equipment connector, future designs specify 8000 psi. Hydraulic fluids used shall be MIL-H-5606, MIL-H-83282, and the future non-flammable fluid under developed by the Wright Research and Development Center. The hydraulic support system design manual should also provide for fluid heating and cooling, deaeration, filtration and removal of moisture.

RELATED EFFORTS:
1) Vickers Fluid Power Limited has several aircraft hydraulic servicing systems installed in England and Germany supporting aircraft production facilities (e.g., the Tornado at Warton Aerodome) and RAF aircraft at St. Athens, Cottesmore, Honnington, and Coningsby. These operate at pressures below 4000 psi and over short distances. 2) NASA supports space orbiter vehicles with hydraulic supply units capable of 54 gpm at 3000 psi or 30 gpm at 5000 psi.

DELIVERABLE REQUIREMENT:
A design handbook in the MIL-PRIME specification format which can be used by the Army Corps of Engineers, the Navy Facilities Engineering Command, or their designated architectural and engineering firms in designing high pressure fluid distribution subsystems in CASS. The Air Force Standard Specification for Pressurized Fuel Systems, 78-24-28-72, may be used as a guide for general type of information required.

PAYOFF/BENEFIT:
Adds to CASS capability being fielded. Handbook would help environmental

LOGISTICS DEVELOPMENT REQUIREMENT

LOGISTICS NEED NUMBER: 87070

TITLE:
Robotic Welding/Inspection System

OBJECTIVE:
Reduce support costs by prototyping a computer-controlled robotic system for welding and inspecting.

PROBLEM:
The problem associated with manual welding is uniform weld quality. Welding skills vary among personnel depending on individual experience and on the types of metals being joined. With these variables added to the 12-15 technical variables of the welding process, all manual welding is a labor intensive art.

RELATED EFFORTS:
PRAM Project No. RA85-9 Robotic Welding System for Process Development and Production

REFERENCES:
AFWAL-TR-87-4012 Robotics Application Study for Air Logistics Centers

DELIVERABLE REQUIREMENT:
Develop, test, supervise installation, train personnel and provide for turn-key operation of an adaptive robotic welding system consisting of two robots operating in different locations with both interconnected under direct command of a single computer controller. The robots should be capable of independent operations using both metal and tungsten inert gas (MIG and TIG) welding processes and be identical except in one feature; the welding laboratory unit shall be equipped with real time X-ray to permit immediate viewing of a weld seam.

PAYOFF/BENEFIT:
The advantages are positive repeatability and speed of production and inspection. These simultaneously increase productivity and decrease the cost per item.

LN CATEGORY/RANKING:

TECHNOLOGY AREA: Robotics

POINT(S)-OF-CONTACT:
Current Sponsor:
Ray Flens, SM-ALC/MAQCC (AFLC), (916) 643-6988 (AV 633-6988)
Original Submitter:
W. Emmons, SM-ALC/MAQCC (AFLC)

LOGISTICS DEVELOPMENT REQUIREMENT

LOGISTICS NEED NUMBER: 87128

TITLE:
Fast Field Repair of Composite Structures

OBJECTIVE:
Field capability of bonding/repairing composites in a matter of minutes to allow quick turnaround for increased sortie generation.

PROBLEM:
New composites are becoming more and more prevalent in today's fighting aircraft. Fast and reliable field repair is required to maintain the aircraft in a ready condition. Thermoplastics with higher processing temperatures will require repair in field environments. This will entail new methods of repair which should produce structurally sound repairs.

RELATED EFFORTS:
Rapid-on-Board Aircraft Repair, PRAM project plan, 1985 number 34884-01, POC Stephen Baker, ASD/AEMOF, (AUTOVON 785-3442)

DELIVERABLE REQUIREMENT:
A small portable device that can bond thermoplastics, metals, and resin fiber composites in 15-20 minutes that does not require large support systems. This device should be capable of repairing 6" diameter holes without compromising the integrity of the structure. It should also be adaptable to run off the airplane's own power system or a small portable generator.

PAYOFF/BENEFIT:
Increased sortie generation, faster turnaround time. Increased availability, survivability, mobility, maintainability and reduced repair costs.

LN CATEGORY/RANKING:

TECHNOLOGY AREA: Structures - NDI/Analysis/Repair

POINT(S)-OF-CONTACT:
Current Sponsor:
Jon Williams, HQ TAC/SMO-R&M, (804) 764-7230 (AV 574-7230)
Original Submitter:
Ken Ronald, AFCOLR/MEL (AFLC)
Jim Wall, HQ TAC/SMO-R&M
Co-Sponsor(s):
Capt Ed Del Real, HQ MAC/LGMW, (618) 256-3005 (AV 576-3005)
MSgt MSgt Carl Mason, SM-ALC/MMER (AFLC), (916) 643-5803 (AV 633-5803)
Mike Siener, SM-ALC/MMEP (AFLC), (916) 643-3810 (AV 633-3810)
SMSgt Herb Garnto, HQ AAC/LGMM, (907) 552-4887 (AV 317-552-4887)

LOGISTICS DEVELOPMENT REQUIREMENT

LOGISTICS NEED NUMBER: 88084

TITLE:
Flush Mount Antennas for Aircraft

OBJECTIVE:
Develop antennas that fit flush against the fuselage.

PROBLEM:
The present blade antennas mounted on the belly of the C-130 are frequently damaged by flying debris. A flush mounted antenna would not be susceptible to the same amount of damage and would require less frequent replacement.

RELATED EFFORTS:
TBD

DELIVERABLE REQUIREMENT:
Develop flush mount antennas to replace the VHF and UHF blade antennas on the C-130.

PAYOFF/BENEFIT:
Improved life cycle cost.

LN CATEGORY/RANKING:

TECHNOLOGY AREA: Communications/Radar

POINT(S)-OF-CONTACT:
Current Sponsor:
Capt Paul Schmonses, HQ MAC/LGR, (618) 256-4045 (AV 576-4045)
Original Submitter:
Capt James D Pauly, HQ MAC/LGR
MAJCOM LN Focal Point:
Capt Paul H. Schmonsees, HQ MAC/LGR, (618) 256-4045 (AV 576-4045)
AFOLTA LN Manager:
Ron Bing, AFOLTA/LQN, (513) 255-2241 (AV 785-2241)
Action Agency:
Dr Boris Tomasic, RADC/EEA, (617) 337-2055 (AV 478-2055)
Other Agencies:
None

LOGISTICS DEVELOPMENT REQUIREMENT

MAJCOM LN Focal Point:
Phil Usrey, HQ AFLC/XPRO, (513) 257-3744 (AV 787-3744)
AFOLTA LN Manager:
Ron Bing, AFOLTA/LQN, (513) 255-2241 (AV 785-2241)
Action Agency:
Capt Wynne Botts, ASD/AEAL, (513) 255-3755 (AV 785-3755)
Other Agencies:
None

LOGISTICS DEVELOPMENT REQUIREMENT

LOGISTICS NEED NUMBER: 89043

TITLE:
Flightline Confidence Checks for Laser Designator/Rangers (LDR)

OBJECTIVE:
Organizational-level (flightline) capability to assess operational status of the laser system on airborne tactical laser designator/rangers (LDR), i.e., Pave Tack (AN/AVQ-26), Pave Spike (AN/AVQ-23), and LANTIRN (AN/AAQ-14).

PROBLEM:
Present LDR technologies do not test the critical operational elements of the laser system after installation on the aircraft. These critical elements include (1) accurate laser boresight, (2) acceptance of laser ranging, (3) laser energy output, and (4) PIM/PRF code acceptance. If any one of these critical elements are out of tolerance (OOT), the LDR is incapable of laser-guided weapons delivery. Also, if either item 1 or item 2 is OOT, navigational input errors will incapacitate conventional weapons delivery as well.

The on-equipment built-in-test (BIT) capability of existing LDRs does not check real energy output or evaluate actual laser returns. Instead, BIT checks are limited to measuring internal voltage levels which simulate outputs and returns. This method of evaluating laser system performance is unreliable and does not address the laser boresight element. Thus, it is possible to have a system that BIT checks good but is, in fact, totally useless for either laser-guided or conventional weapons delivery.

Intermediate-level checkout capability alone is not adequate as it does not permit diagnosis without uncoupling the system from the aircraft and transporting it to an intermediate-level facility. In the case of the system that checks good at the intermediate-level facility, unnecessary manhours have been expended, equipment/personnel have been tied up unnecessarily, and additional wear and tear has occurred on the system due to mating/demating. Multiply this situation for a whole wing of aircraft, all having LDR systems permanently installed, and the problem becomes even more acute.

Flightline tester technology is available as a remedy for existing LDRs. The Hughes Aircraft Company has manufactured a prototype laser and forward looking infrared (FLIR) test set (LAFTS) which permits flightline technicians to assess laser performance in minutes, and without demating the LDR system from the aircraft. Systems that are OOT are quickly and accurately identified and sent to the intermediate-level repair facility. Systems that check good are left on the aircraft for the next mission.

RELATED EFFORTS:
Hughes Aircraft Company Laser and FLIR Test Set (LAFTS) development. AFLC POC: Lou Timmons, SM-ALC/MMKREB, AV 633-5883. Hughes POC: Rudy F. Trevison, Test Equipment Marketing, (213) 513-4614/4615, P.O. Box 9399, Long Beach, CA 98081-0468. WR-ALC POC: Bob Whitley, WR-ALC/MMIMG (Pave Tack, Pave Spike Program Manager), AV 468-3122.

89043

LOGISTICS DEVELOPMENT REQUIREMENT

LOGISTICS NEED NUMBER: 89045

TITLE:
Bulk Fuel Storage Bladder Tank

OBJECTIVE:
Provide a bulk fuel storage bladder tank, constructed with high tensile-strength materials, which will afford reliable service for support of aviation/ground petroleum storage requirements in combat and peacetime training scenarios specifically in a bare/austere basing environment.

PROBLEM:
Existing bladder tanks procured under MIL-T-52983 have consistently demonstrated less than adequate performance, reliability and durability. Historically, catastrophic seam failure/separations, thru-vall leaks and fabric punctures have resulted in fuel spills of up to 50,000 gallons. DOD activities have been conducting fuel bladder research and development for approximately 20 years without significant product improvement. The ramifications of a bladder failure and subsequent spill impact combat support, the environment, budget, energy conservation and safety.

RELATED EFFORTS:
TAF 311-83 Statement of Operational Need (SON) for Bladder, Bulk Fuel Storage, 27 Nov 85. OPR: TAC/LGSF, Mr Heath, AV 574-2057. LN 89090, Portable Arctic-Capable Fuel Containers, has been merged into this LN.

DELIVERABLE REQUIREMENT:
A bladder tank with capacity of 35-60,000 gallons that will provide extended and reliable service. Necessary characteristics include: wetted service life of 10 years; dry shelf-life of 20 years; improved construction to resist seam failures, abrasions, thru-vall leaks and punctures; compatible with military and commercial specification fuels of all types; max gross packaged weight of 2,500 LBS; unrestricted service within temperature range of -75 to + 140 degrees Fahrenheit; repairable with appropriate patches; max ground contact surface of 2,800 square feet when filled to capacity.

PAYOFF/BENEFIT:
Improve combat sustainability and reduce USAF operating costs by approximately $2.75 million dollars annually. Reduce the potential for environmental damage resulting from USAF use of existing bladders with a 20 year history of structural failures. Improve fuel availability in deployed combat environment.

LN CATEGORY/RANKING:

TECHNOLOGY AREA: Hydraulics/Fuels/Fluids

LOGISTICS DEVELOPMENT REQUIREMENT

LOGISTICS NEED NUMBER: 89085

TITLE:
Arctic-Capable Communications Trailer/Pod and Antennas

OBJECTIVE:
Design/procure an air-transportable communications trailer/pod suitable for operations in the arctic environment. Antennas must be designed for operations in extreme cold temperatures and in periods of high winds.

PROBLEM:
Current deployable communications trailers/pods are designed for normal operating temperatures and do not fully function in extreme cold environments. Antennas are susceptible to high wind damage and are not designed for extreme cold, where metals become brittle. Due to current designs, maintenance requirements are high.

RELATED EFFORTS:
None Known

DELIVERABLE REQUIREMENT:
An air-transportable communications trailer/pod capable of operation in temperatures as low as -100 degrees Fahrenheit. Antennas must be designed for extreme cold temperatures and winds up to 70 mph.

PAYOFF/BENEFIT:
Enhance/ensure communications with main operating bases and the battle staff.

LN CATEGORY/RANKING:

TECHNOLOGY AREA: Communications/Radar

POINT(S)-OF-CONTACT:
Current Sponsor:
Lt Col Nibeck, HQ AAC/LGX, (907) 552-5424 (AV 317-552-5424)
Original Submitter:
Lt Col Nibeck, HQ AAC/LGX
MAJCOM LN Focal Point:
Randy D. Barker, HQ AAC/LGXX, (907) 552-5480 (AV 317-552-5480)
AFOLTA LN Manager:
Ron Bing, AFOLTA/LQN, (513) 255-2241 (AV 785-2241)
Action Agency:
George Pfeiffer, RADC/DCCL, (315) 330-3077, (AV 587-3077)
Other Agencies:
NAVY, POC: Don Simon, Naval Supply Systems Command (Code SUP55), (202) 692-2554 (AV 222-2554)

PART II

Using the attached score sheets, score each LN based upon its attributes. You can use the book description and your personal understanding of the LNs when completing the score sheets.

Every participant will score each LN on seven attributes. In addition to these seven, you have the option of selecting up to three more attributes from the list of attributes. IMPORTANT: If you elect to score more than seven attributes, you must use the same attributes for all 12 LNs.

For each of the attributes (except cost), the more an LN is characterized by that attribute, the higher the score of that attribute. As for cost, which is optimal when minimized, a less costly LN has a higher score on the cost attribute.

Attributes for LN Prioritization
From Rounds One and Two
Explanation and Definition

Required to be Scored:

1. Mission Requirement/Impact - The impact on the operational mission: for example, impact on sortie rates. Does LN affects training, methods and procedures, equipment, or weapon systems? What is impact if LN is not fulfilled? Higher score for greater mission impact.

2. Pervasiveness - The extent to which an LN affects the entire Air Force versus a single command, several weapon systems versus only one. How wide is the need or application of the solution? Wider application would be indicated with a higher score.

3. Reliability & Maintainability - The extent to which the LN improves reliability/maintainability of the affected systems. A higher score depicts greater effect on R&M.

4. Payback - Dollar and manpower savings due to meeting the requirements of the LN. Greater payback is indicated with a higher score.

5. Cost to Develop and Implement - Cost in absolute terms. Is cost of satisfying need reasonable? Will the R&D effort for this LN cost more than it will save? A more costly LN would receive a lower score than a less expensive LN; closer to 100 indicates less costly, closer to 0 indicates greater expense.

6. Safety Impact - The degree to which the LN would prevent loss of life or loss of equipment. Solution to a flight or ground safety problem. Greater safety impact is reflected in a higher score.

7. Feasibility/Probability of Technical Success - The availability of technology in the near future; the likelihood of solution in the near term; the level of effort in the labs. Is it still a theoretical concept in the laboratories or is it an existing technology ready for application? Is the LN realistic? A "certain thing", technically speaking, would receive a score of 100. Less certain probability of success would receive a lower score.

List of Attributes (cont)

Optional:

8. Command Interest - The level of applicability to my own MAJCOM. Is this particular LN significant to my MAJCOM?

9. Consistency with Air Force Goals, Objectives, and Strategies - Extent to which the LN supports the Air Force directives and policy directions versus satisfying individual MAJCOM whims.

10. Threat Environment Impact - Degree to which the LN resolves or improves capabilities against a specific threat.

11. Actual "Need" versus "Want" - Degree to which the LN's solution will actually be used. Will it be used, or is it just a good idea?

12. Timeliness - The length of time until technology is available to solve the LN.

13. Effectiveness - How well the solution actually solves the need. Is solution complete and effective, or merely a step towards final resolution?

14. Probability of Funding - If technology were available to fulfill the LN requirements, with what degree of certainty would my MAJCOM provide funding to implement the LN? Can funding and tasking be obtained to support R&D for the need?

15. Life Expectancy of Item - Length of time an item will be in the inventory.

16. Usability - The degree to which the LN resolution will be war friendly, easy to operate, reliable and maintainable.

17. Significance to Originator - The importance the originator (sponsor) places on the LN relative to all other LNs (overall, and of those sponsored by the originator). Where does the originator think the need falls in the overall scheme of his operations?

18. Application: Now or Later? - Is this a LN to resolve a problem with currently fielded weapon systems or a forseen deficiency for future systems?

19. Work Arounds - Number and potential for other solutions to solve LN. Are there other ways of meeting need?

20. Spin-Off - Breadth of application of the LN solution beyond the original need. Does the technology needed to resolve the LN have a broader application?

Score Sheet

LN# 82047 TITLE: Maintenance of Advanced/Next Generation Fan Stage Configuration

Indicate with a circle or "X", the score you assign each attribute for this LN.

Attribute	Score (0 — 50 — 100)
Mission Impact	
Pervasiveness	
Reliability & Maintainability	
Payback	
Cost	
Safety Impact	
Feasibility/Prob of Tech Success	
_____	
_____	
_____	

Score Sheet

LN# 83046 TITLE: Chemical Protective Suit

Indicate with a circle or "X", the score you assign each attribute for this LN.

Attribute	Score (0 — 50 — 100)
Mission Impact	
Pervasiveness	
Reliability & Maintainability	
Payback	
Cost	
Safety Impact	
Feasibility/Prob of Tech Success	
_____	
_____	
_____	

Score Sheet

LN# 84011 TITLE: Aircrew Training Devices Deployment Concept

Indicate with a circle or "X", the score you assign each attribute for this LN.

Attribute	Score (0 — 50 — 100)
Mission Impact	
Pervasiveness	
Reliability & Maintainability	
Payback	
Cost	
Safety Impact	
Feasibility/Prob of Tech Success	
_____	
_____	
_____	

Score Sheet

LN# 85009 TITLE: Standardized Power Supplies

Indicate with a circle or "X", the score you assign each attribute for this LN.

Attribute	Score (0 — 50 — 100)
Mission Impact	
Pervasiveness	
Reliability & Maintainability	
Payback	
Cost	
Safety Impact	
Feasibility/Prob of Tech Success	
_____	
_____	
_____	

Score Sheet

LN# 87033 TITLE: Database for High-Pressure Underground Pipe

Indicate with a circle or "X", the score you assign each attribute for this LN.

Attribute	Score (0 — 50 — 100)
Mission Impact	
Pervasiveness	
Reliability & Maintainability	
Payback	
Cost	
Safety Impact	
Feasibility/Prob of Tech Success	
_____	
_____	
_____	

Score Sheet

LN# 87070 TITLE: Robotic Welding/Inspection System

Indicate with a circle or "X", the score you assign each attribute for this LN.

Attribute	Score (0 — 50 — 100)
Mission Impact	
Pervasiveness	
Reliability & Maintainability	
Payback	
Cost	
Safety Impact	
Feasibility/Prob of Tech Success	
_____	
_____	
_____	

Score Sheet

LN# 87128 TITLE: Fast Field Repair of Composite Structures

Indicate with a circle or "X", the score you assign each attribute for this LN.

Attribute	Score (0 — 50 — 100)
Mission Impact	
Pervasiveness	
Reliability & Maintainability	
Payback	
Cost	
Safety Impact	
Feasibility/Prob of Tech Success	
_____	
_____	
_____	

Score Sheet

LN# 88084 TITLE: C-130 Flush Mount Antenna

Indicate with a circle or "X", the score you assign each attribute for this LN.

Attribute	Score (0 — 50 — 100)
Mission Impact	
Pervasiveness	
Reliability & Maintainability	
Payback	
Cost	
Safety Impact	
Feasibility/Prob of Tech Success	
_____	
_____	
_____	

Score Sheet

LN# 89031 TITLE: N-1 Compass Systems Amplifier Replacements

Indicate with a circle or "X", the score you assign each attribute for this LN.

Attribute	Score (0 — 50 — 100)
Mission Impact	
Pervasiveness	
Reliability & Maintainability	
Payback	
Cost	
Safety Impact	
Feasibility/Prob of Tech Success	
_____	
_____	
_____	

Score Sheet

LN# 89043 TITLE: Flightline Checks for Laser Designator/Ranger

Indicate with a circle or "X", the score you assign each attribute for this LN.

Attribute	Score (0 — 50 — 100)
Mission Impact	
Pervasiveness	
Reliability & Maintainability	
Payback	
Cost	
Safety Impact	
Feasibility/Prob of Tech Success	
_____	
_____	
_____	

Score Sheet

LN# 89045 TITLE: Bulk Fuel Storage Bladder Tank

Indicate with a circle or "X", the score you assign each attribute for this LN.

Attribute	Score (0 — 50 — 100)
Mission Impact	
Pervasiveness	
Reliability & Maintainability	
Payback	
Cost	
Safety Impact	
Feasibility/Prob of Tech Success	
_____	
_____	
_____	

Score Sheet

LN# 89085 TITLE: Artic Communications Trailer/Pod and Antenna

Indicate with a circle or "X", the score you assign each attribute for this LN.

Attribute	Score (0 — 50 — 100)
Mission Impact	
Pervasiveness	
Reliability & Maintainability	
Payback	
Cost	
Safety Impact	
Feasibility/Prob of Tech Success	
_____	
_____	
_____	

Appendix F. Individual and Group Results from Round 3

This appendix contains the ordinal and TOPSIS results for each of the six decision makers. Both tables comparing the rankings and graphs are included.

DM #1

LN#	Ordinal Rank	TOPSIS Rank	(ERROR)^2
83046	1	4	9.00
89045	2	3	1.00
87128	3	2	1.00
85009	4	1	9.00
87070	5	5	.00
89031	6	11	25.00
89085	7	10	9.00
88084	8	12	16.00
82047	9	7	4.00
84011	10	8.5	2.25
87033	11	6	25.00
89043	12	8.5	12.25
		SSE =	113.50
		StDev =	1.07

DM #2

LN#	Ordinal Rank	TOPSIS Rank	(ERROR)^2
83046	1	1	.00
87128	2	2	.00
89031	3	4	1.00
88084	4	9	25.00
89043	5	7	4.00
89045	6	6	.00
87070	7	10	9.00
87033	8	5	9.00
89085	9	8	1.00
84011	10	11	1.00
85009	11	3	64.00
82047	12	12	.00
		SSE =	114.00
		StDev =	1.07

DM #3

LN#	Ordinal Rank	TOPSIS Rank	(ERROR)^2
83046	1	3	4.00
87128	2	1	1.00
89045	3	2	1.00
87070	4	6	4.00
85009	5	5	.00
89043	6	4	4.00
89031	7	9	4.00
89085	8	10	4.00
82047	9	8	1.00
88084	10	7	9.00
84011	11	11	.00
87033	12	12	.00
		SSE =	32.00
		StDev =	.57

DM #4

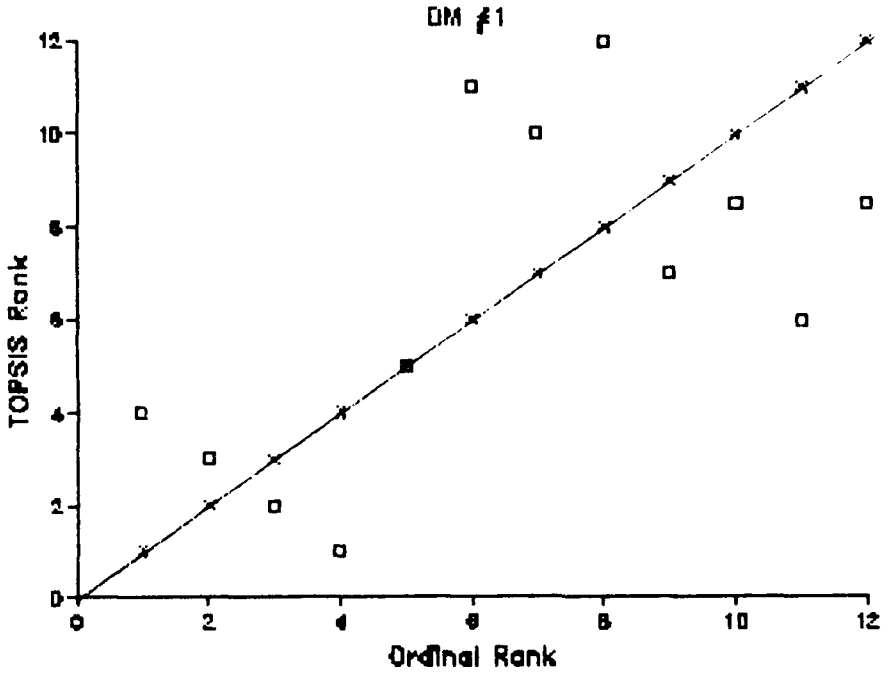
LN#	Ordinal Rank	TOPSIS Rank	(ERROR)^2
87128	1	2	1.00
83046	2	1	1.00
89031	3	4	1.00
88084	4	5	1.00
89045	5	3	4.00
89043	6	7.5	2.25
87070	7	6	1.00
85009	8	10	4.00
89085	9	9	.00
82047	10	7.5	6.25
84011	11	11	.00
87033	12	12	.00
		SSE =	21.50
		StDev =	.46

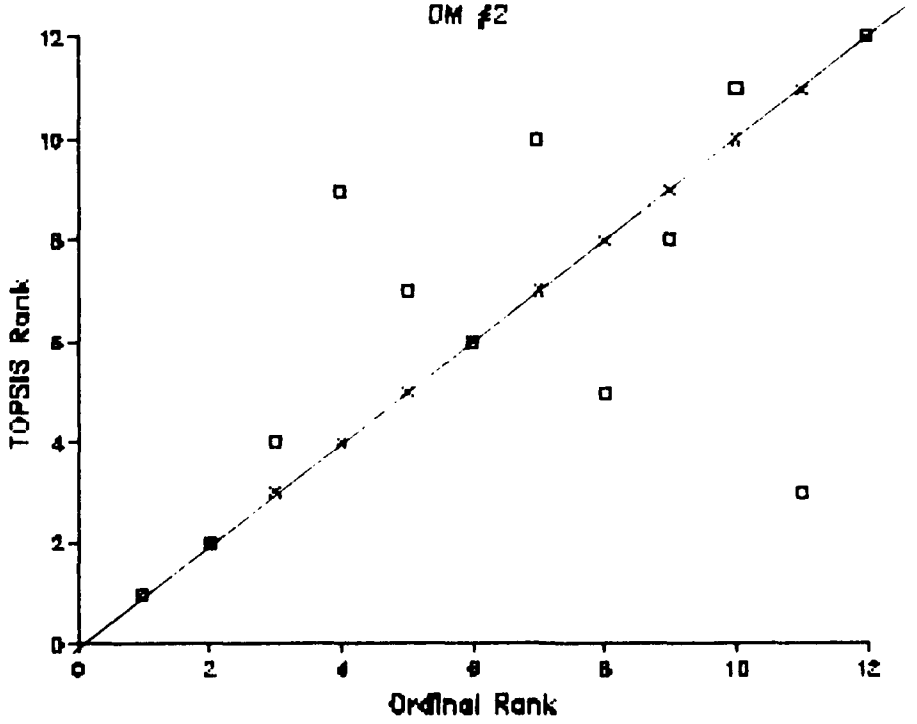
DM #5

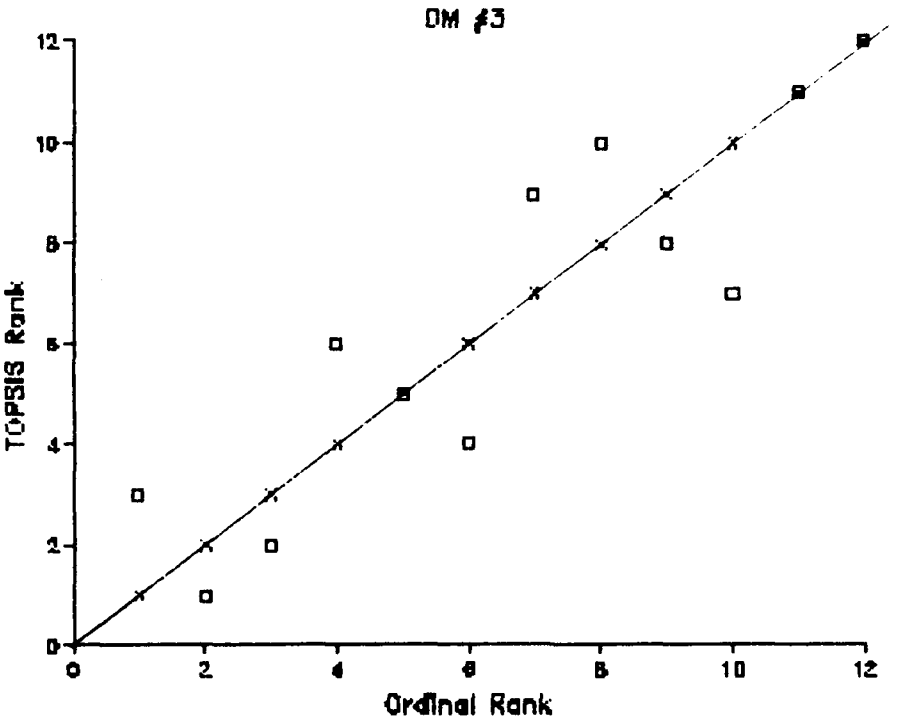
LN#	Ordinal Rank	TOPSIS Rank	(ERROR)^2
89043	1	1	.00
87128	2	2	.00
89045	3	3	.00
89085	4	9	25.00
83046	5	5	.00
89031	6	4	4.00
88084	7	10	9.00
87070	8	7	1.00
85009	9	6	9.00
82047	10	8	4.00
84011	11	12	1.00
87033	12	11	1.00
		SSE =	54.00
		StDev =	.73

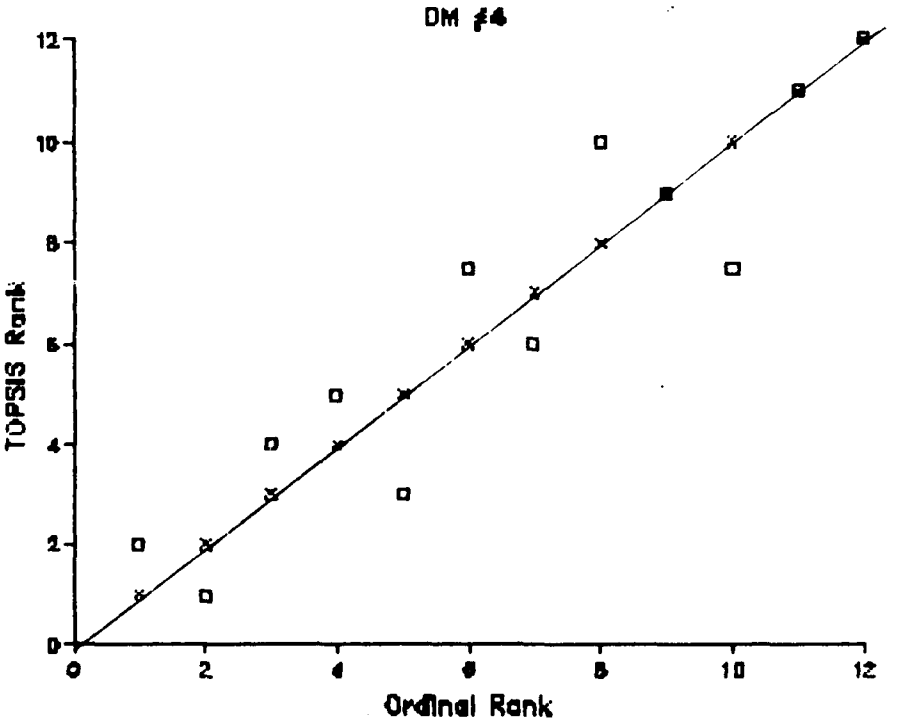
DM #6

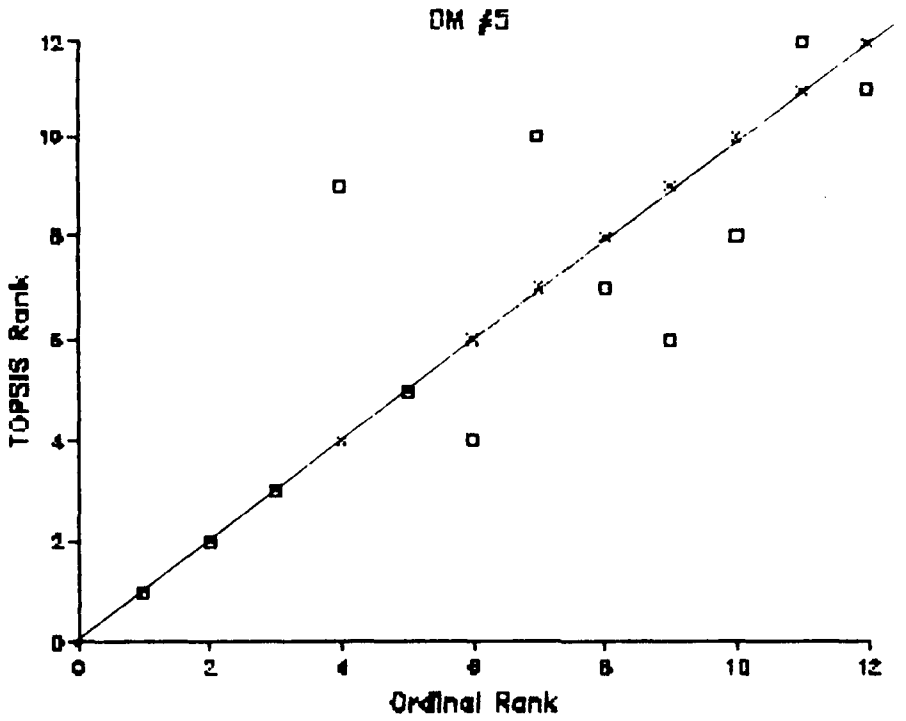
LN#	Ordinal Rank	TOPSIS Rank	(ERROR)^2
89043	8	4	16.00
87128	3	7	16.00
89045	7	12	25.00
89085	10	10	.00
83046	4	2	4.00
89031	9	9	.00
88084	11	8	9.00
87070	2	5	9.00
85009	1	1	.00
82047	6	3	9.00
84011	5	6	1.00
87033	12	11	1.00
		SSE =	90.00
		StDev =	.95

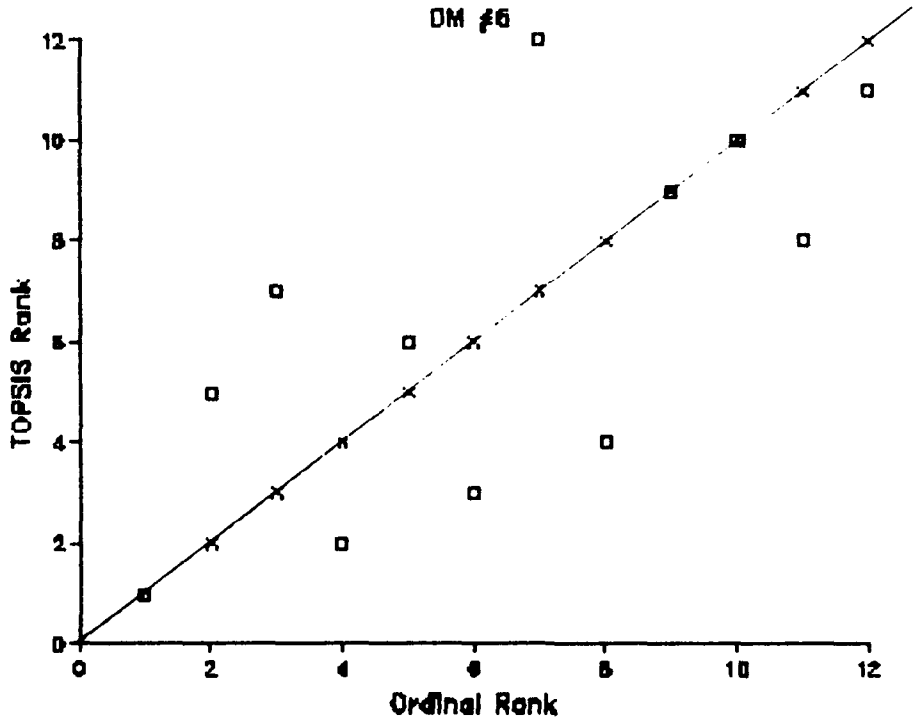

DM #1
TOPSIS Rank
Ordinal Rank
0
2
4
6
8
10
12


DM #2
TOPSIS Rank
Ordinal Rank
0
2
4
6
8
10
12


DM #3
TOPSIS Rank
Ordinal Rank
0
2
4
6
8
10
12


DM #4
TOPSIS Rank
Ordinal Rank
0
2
4
6
8
10
12


DM #5
TOPSIS Rank
Ordinal Rank
0
2
4
6
8
10
12


DM #6
TOPSIS Rank
Ordinal Rank
0
2
4
6
8
10
12

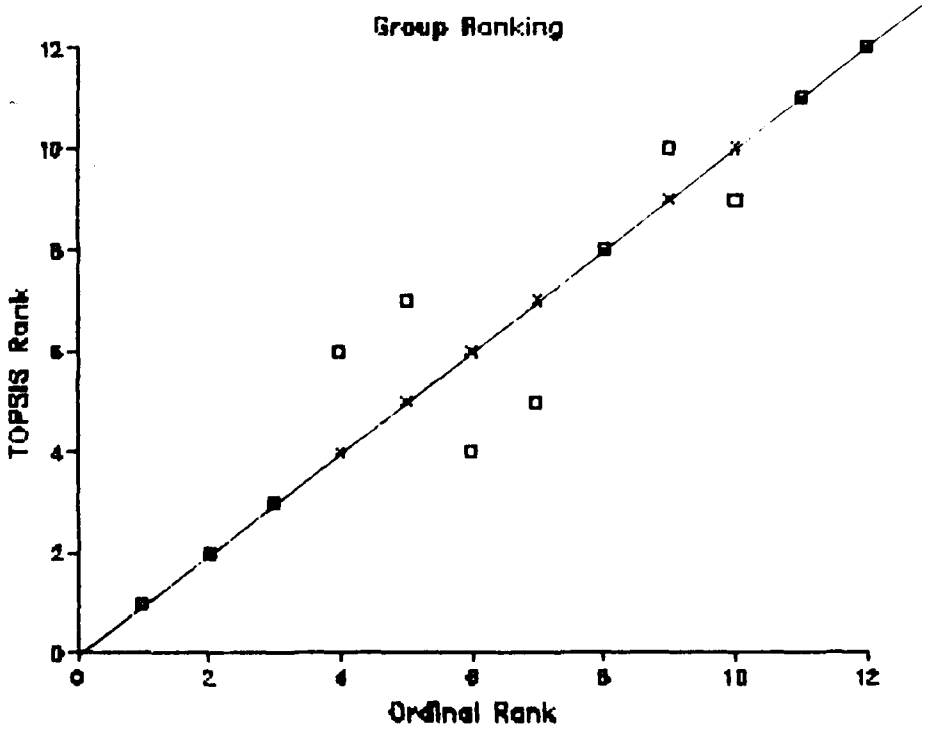
Ordinal Rankings

	DM1	DM2	DM3	DM4	DM5	DM6	Avg	StDev
87128	3	2	2	1	2	3	2.17	.75
83046	1	1	1	2	5	4	2.33	1.75
89045	2	6	3	5	3	7	4.33	1.97
87070	5	7	4	7	8	2	5.50	2.26
89031	6	3	7	3	6	9	5.67	2.34
85009	4	11	5	8	9	1	6.33	3.67
89043	12	5	6	6	1	8	6.33	3.61
88084	8	4	10	4	7	11	7.33	2.94
89085	7	9	8	9	4	10	7.83	2.14
82047	9	12	9	10	10	6	9.33	1.97
84011	10	10	11	11	11	5	9.67	2.34
87033	11	8	12	12	12	12	11.17	1.60

TOPSIS: Relative Closeness Scores

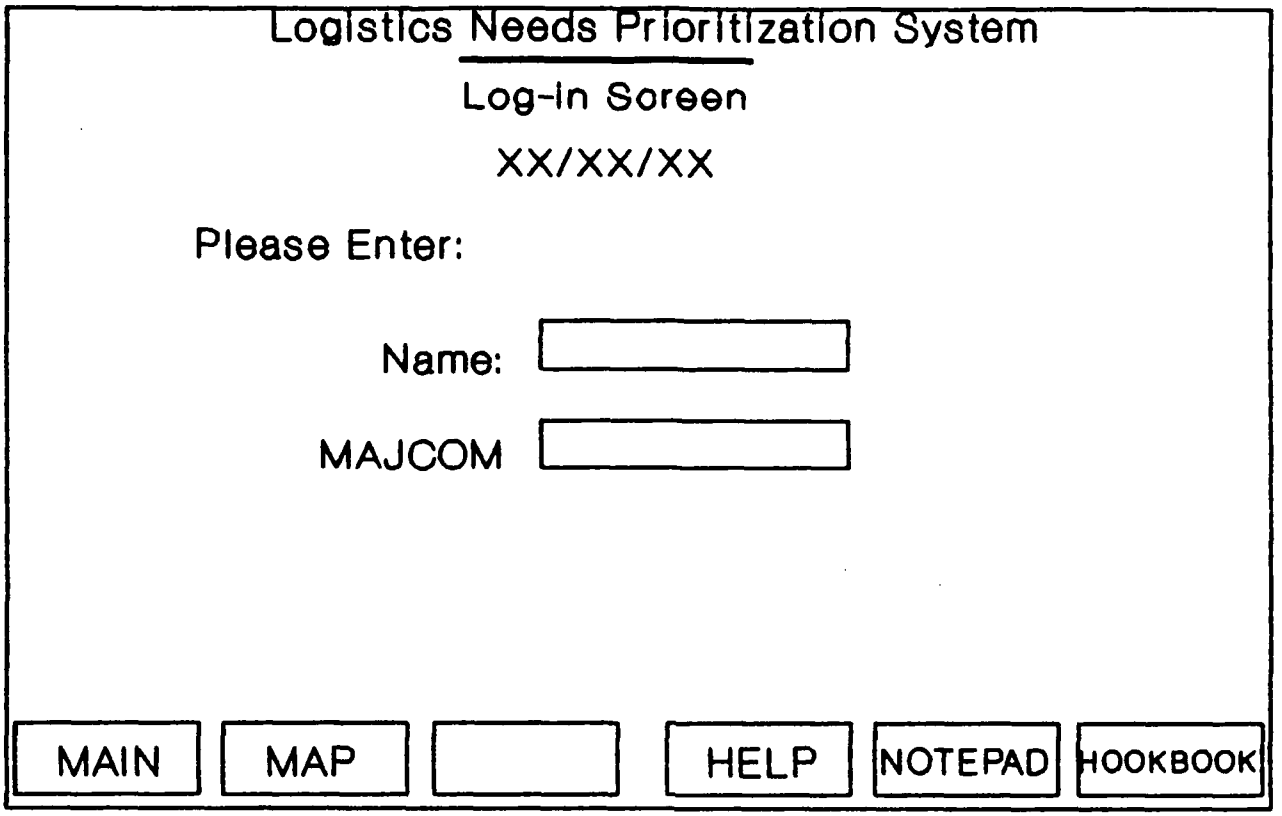
	DM1	DM2	DM3	DM4	DM5	DM6	Avg	StDev
87128	.75	.59	.89	.82	.68	.41	.69	.22
83046	.69	.72	.75	.83	.49	.57	.68	.16
89045	.70	.44	.84	.78	.65	.30	.62	.27
85009	.81	.52	.63	.39	.48	.60	.57	.19
89043	.36	.42	.70	.49	.68	.51	.53	.18
87070	.61	.38	.61	.54	.44	.50	.51	.12
89031	.29	.49	.30	.76	.54	.35	.46	.23
88084	.22	.39	.46	.68	.31	.36	.40	.20
82047	.45	.11	.37	.49	.41	.54	.40	.20
89085	.31	.41	.29	.45	.39	.34	.37	.08
84011	.36	.34	.20	.34	.19	.43	.31	.12
87033	.46	.47	.06	.12	.27	.33	.29	.22

	Group Ranking		
LN#	Ordinal Rank	TOPSIS Rank	(ERROR)^2
87128	1	1	.00
83046	2	2	.00
89045	3	3	.00
87070	4	6	4.00
89031	5	7	4.00
85009	6	4	4.00
89043	7	5	4.00
88084	8	8	.00
89085	9	10	1.00
82047	10	9	1.00
84011	11	11	.00
87033	12	12	.00
		SSE =	18.00
		StDev =	.42



Appendix G. Storyboards of the Kernel System

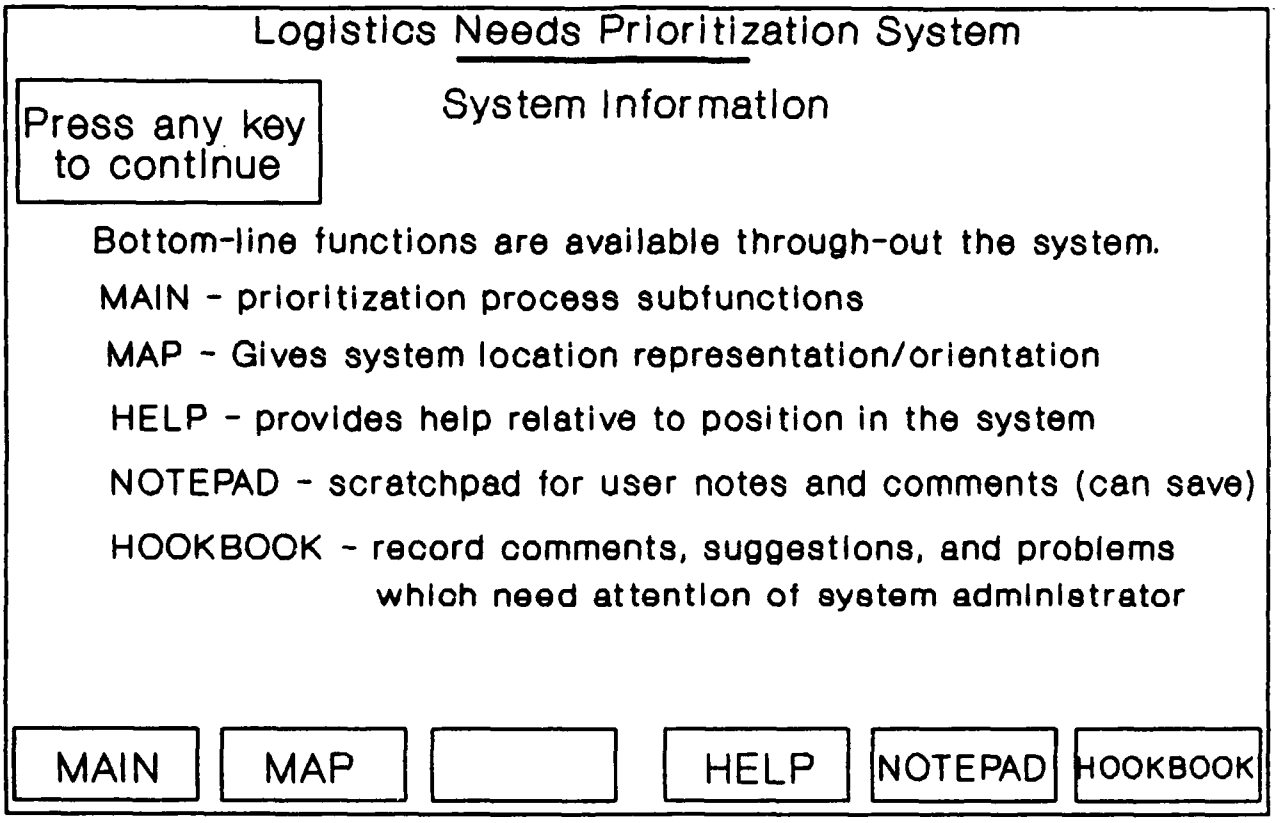
This appendix contains the storyboards representing the screen displays of the kernel system. The storyboards serve as a tool for the GDSS user and designer to describe and document the intended system.



1. This first screen conducts a "log-in", prompting the user for name and MAJCOM which will be recorded in order to document the session.

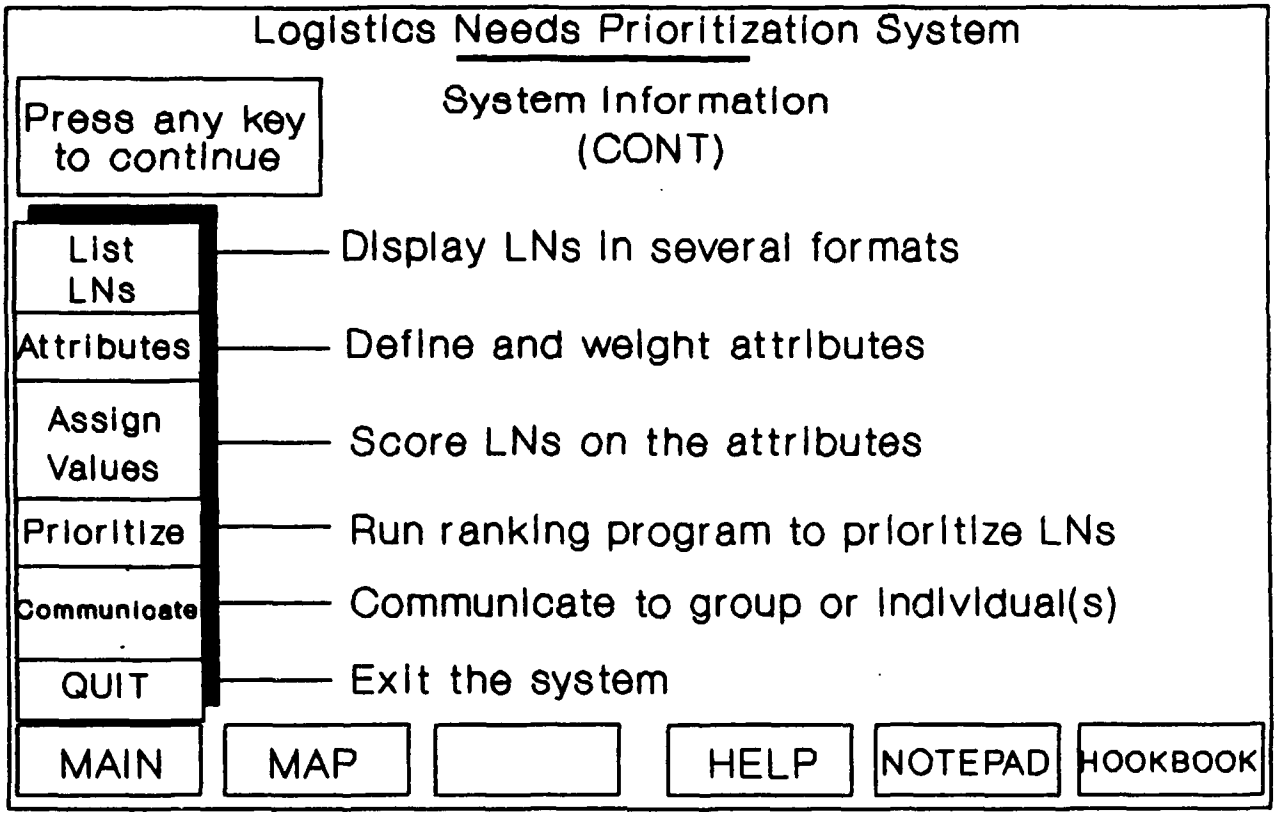
2. After completing the log-in, the system presents a series of information screens.

3. The user of this system will most always be a "novice" since they use the system infrequently. Because of this, the storyboards are designed more towards the novice versus the expert end of the user spectrum as far as computer literacy goes.

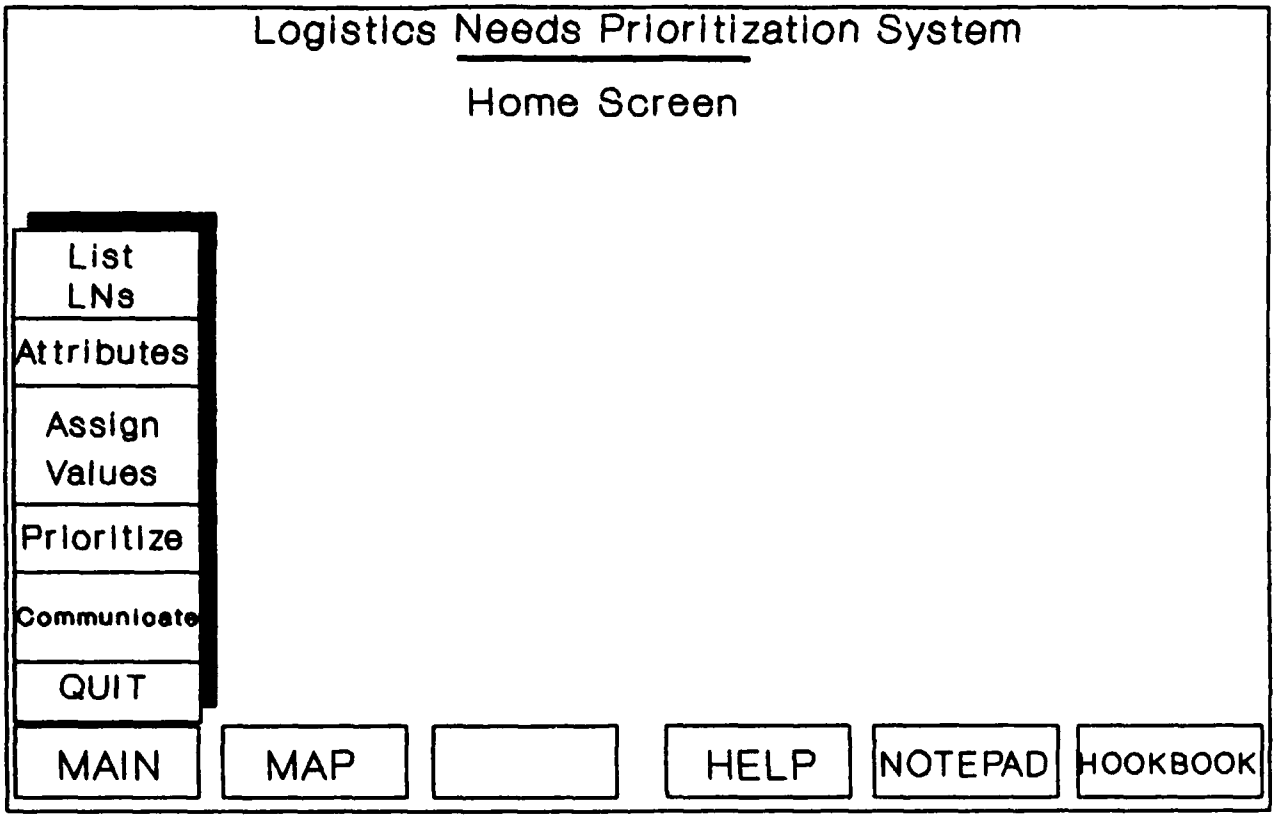


1. The information screen gives the user a brief overview of the bottom-line functions which will be available throughout the system.

2. Further explanation of these functions is available through the Help function.

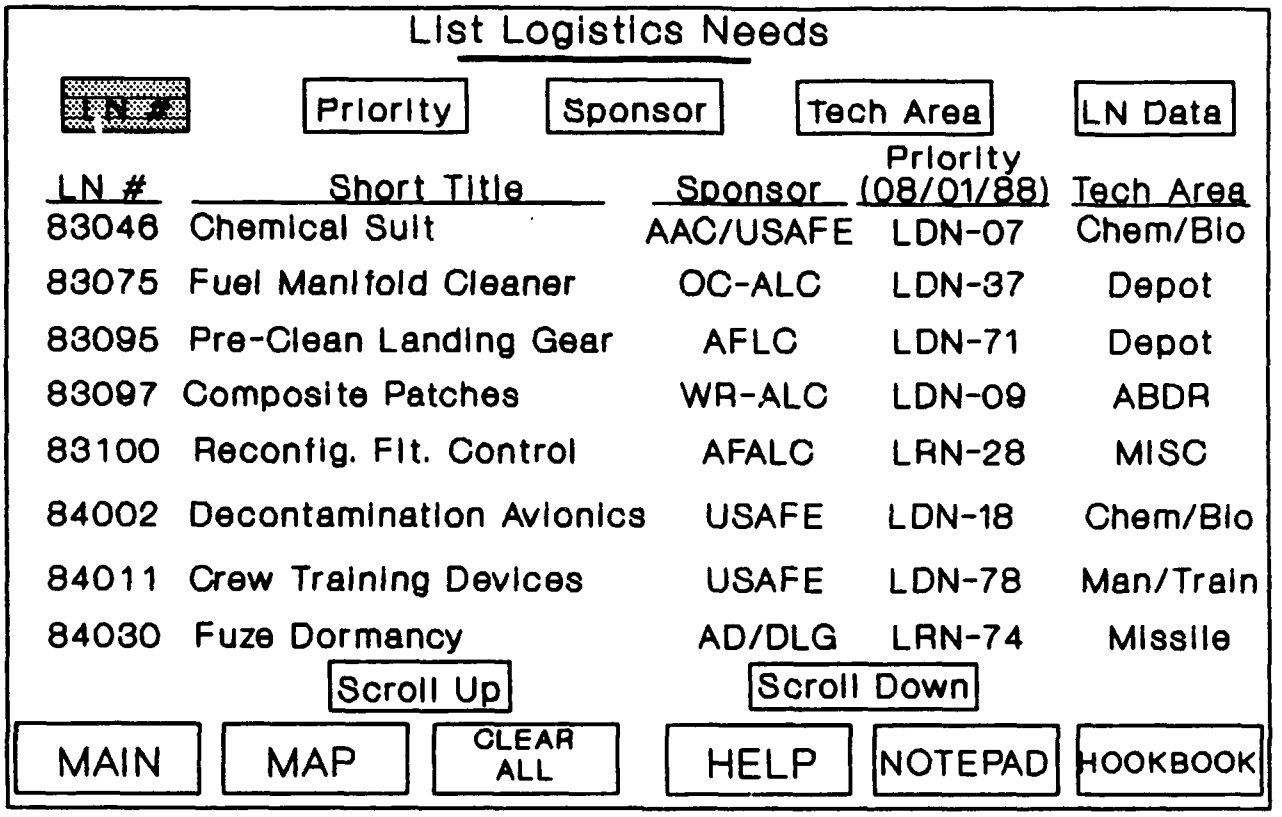


1. This second information screen describes the Main functions -- the basic steps in the LN prioritization process. These functions are available throughout the system and can be invoked in any order.



1. This is the Home Screen. Simple, yet with the Main functions highlighted, it provides assistance in accomplishing the steps of ranking LNs.

2. From this screen the user can select any of the Main or bottom-line functions.

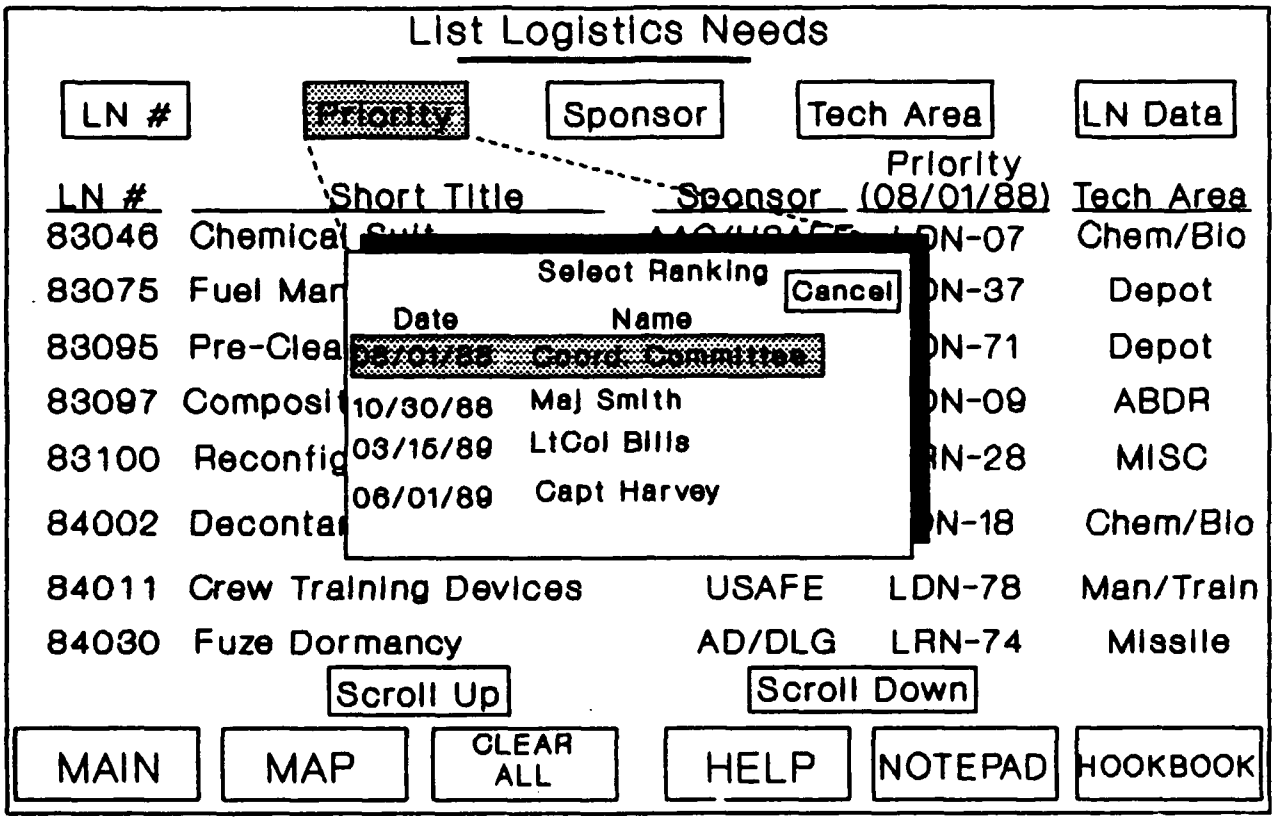


1. Having selected List LNs from the Main menu, the user is presented this screen displaying the LNs in numerical order (by LN #).

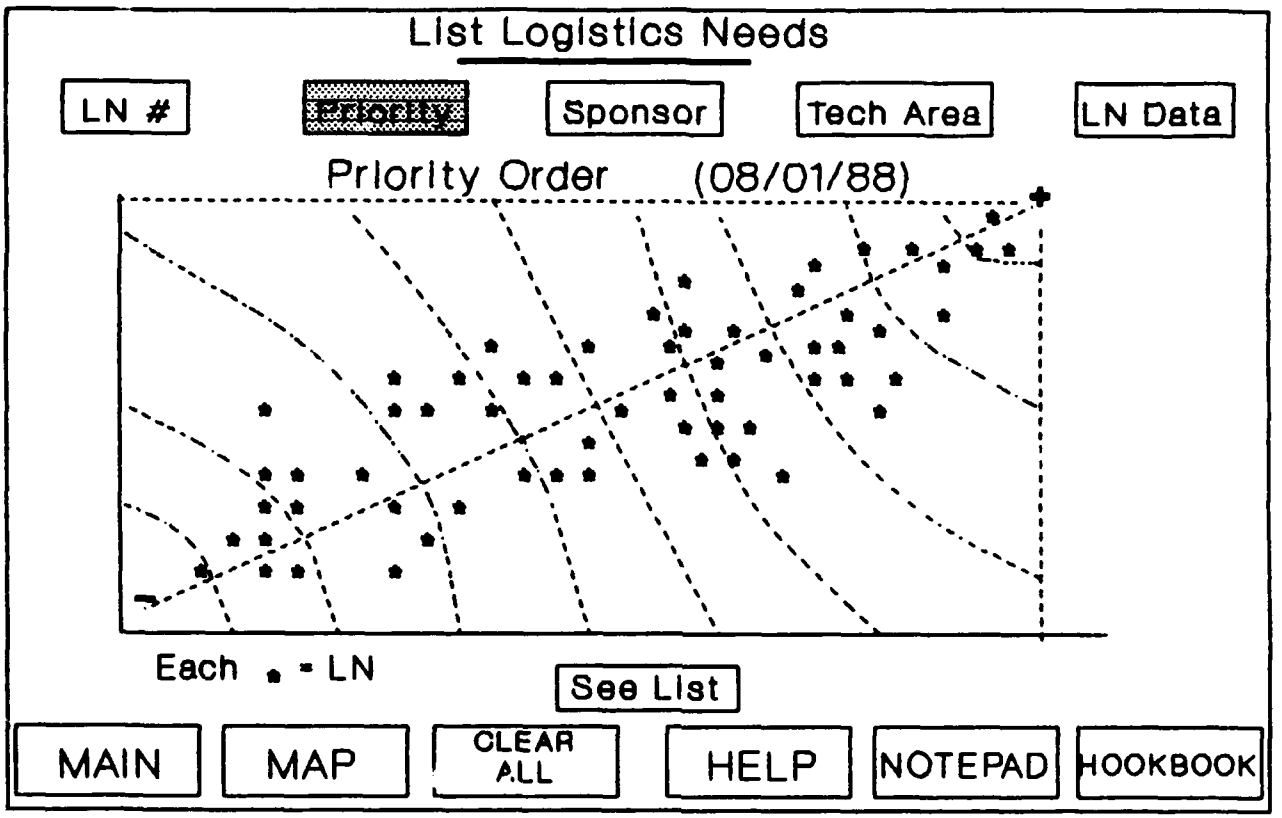
2. The user can opt to list the LNs in other orders: priority, by sponsor, or by Technology Area.

3. The user can also select to examine more information about a specific LN.

4. From this and all following screens, the bottom-line Main function brings-up the Main function menu. Clear All returns the user to the Home Screen.

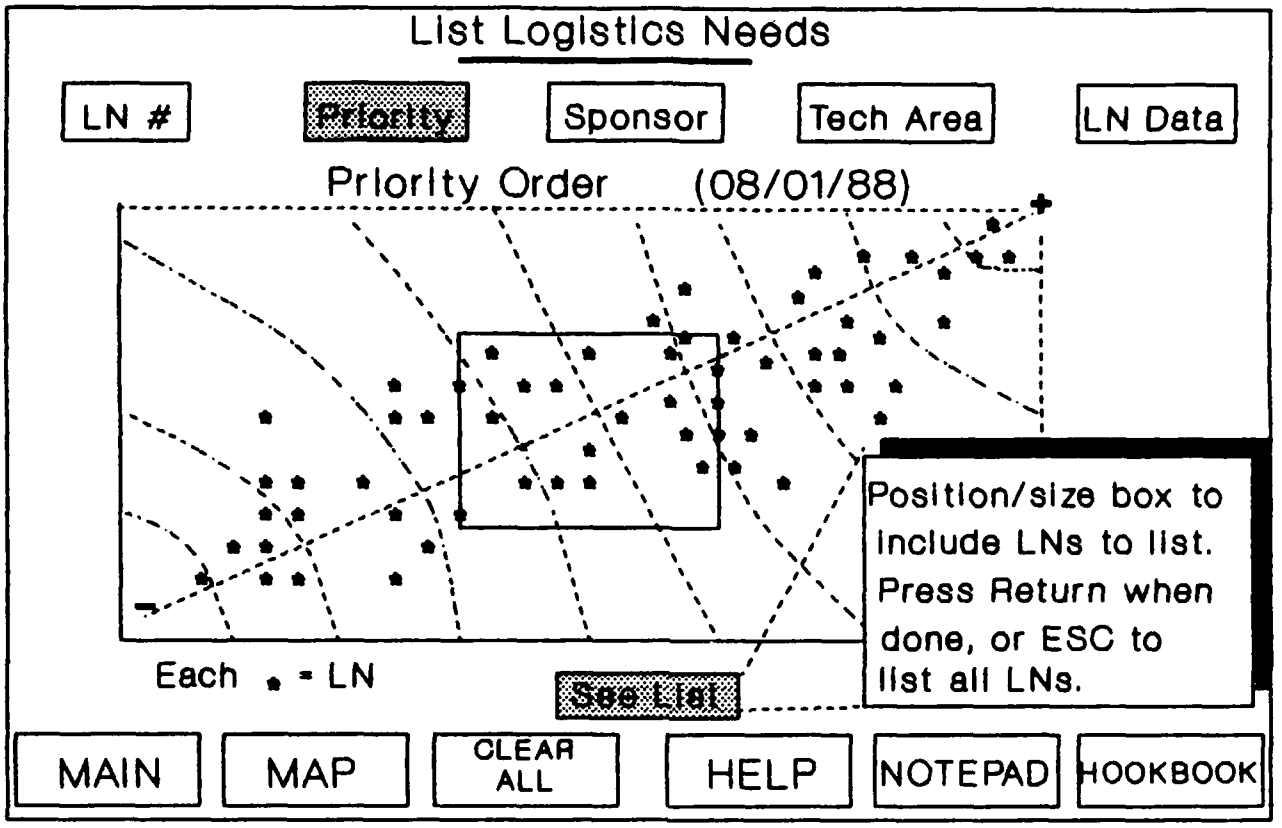


1. Selecting to see the LNs in priority order produces a window from which the user selects the past priority order he wishes to examine.

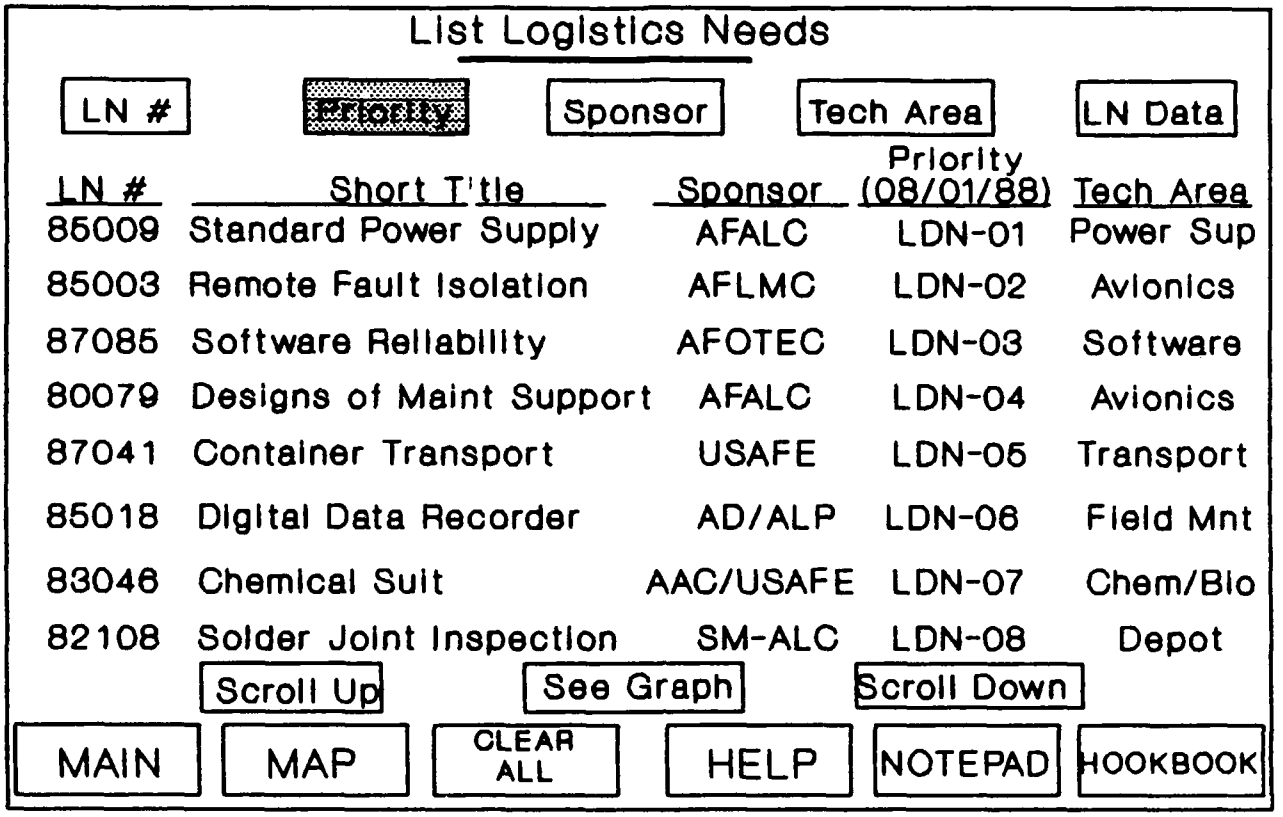


1. Having selected the desired priority order, a graphical representation of that order is presented. The "+" indicates the more highly ranked LNs while the lower-ranked are nearer the "-" (TOPSIS's ideal and negative-ideal points).

2. The user can examine the graph for groupings within the ranking. It may be desirable to further review the rankings of LNs grouped closely together.

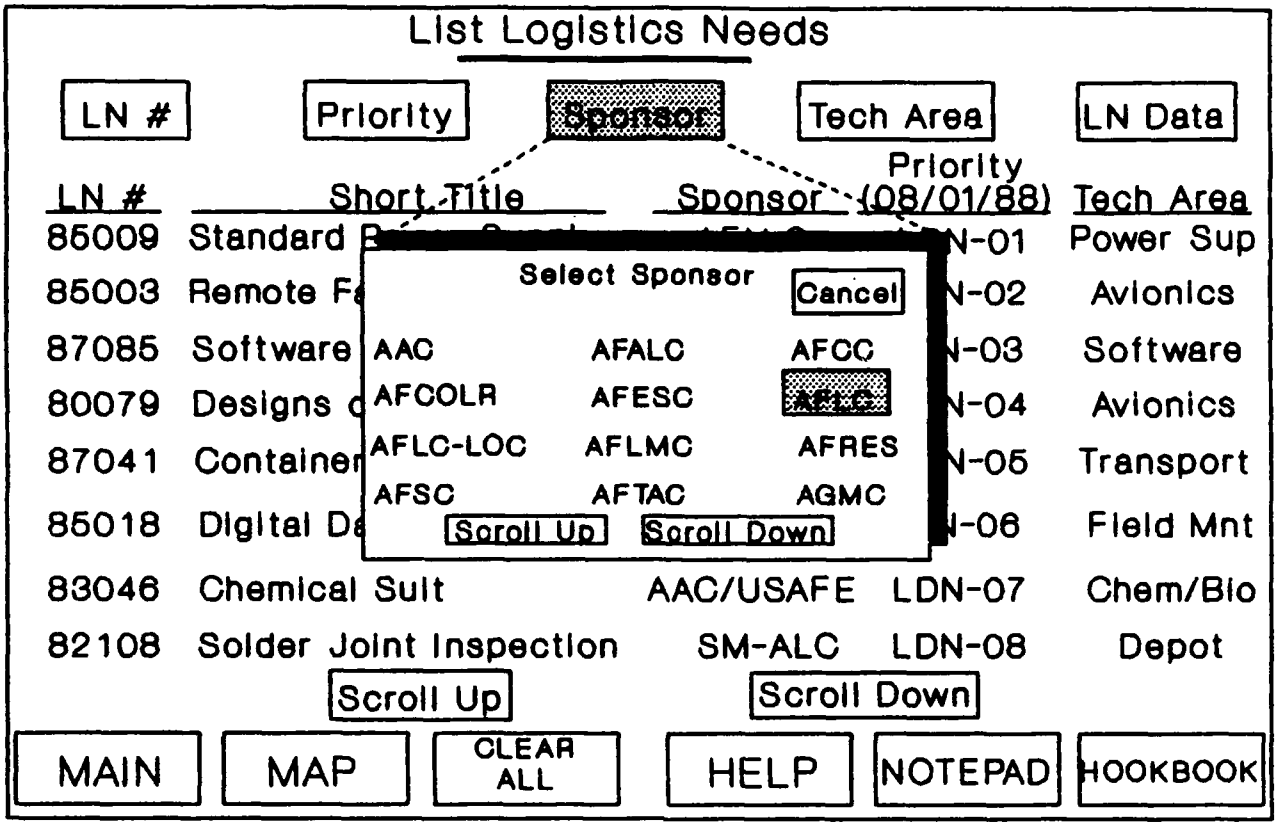


1. Selecting to transition from the graph to a list of LNs, the user picks those LNs to include in the list. This is useful for examining a group, or subset of the list. The user can also choose to examine the entire list of LNs in their priority order.

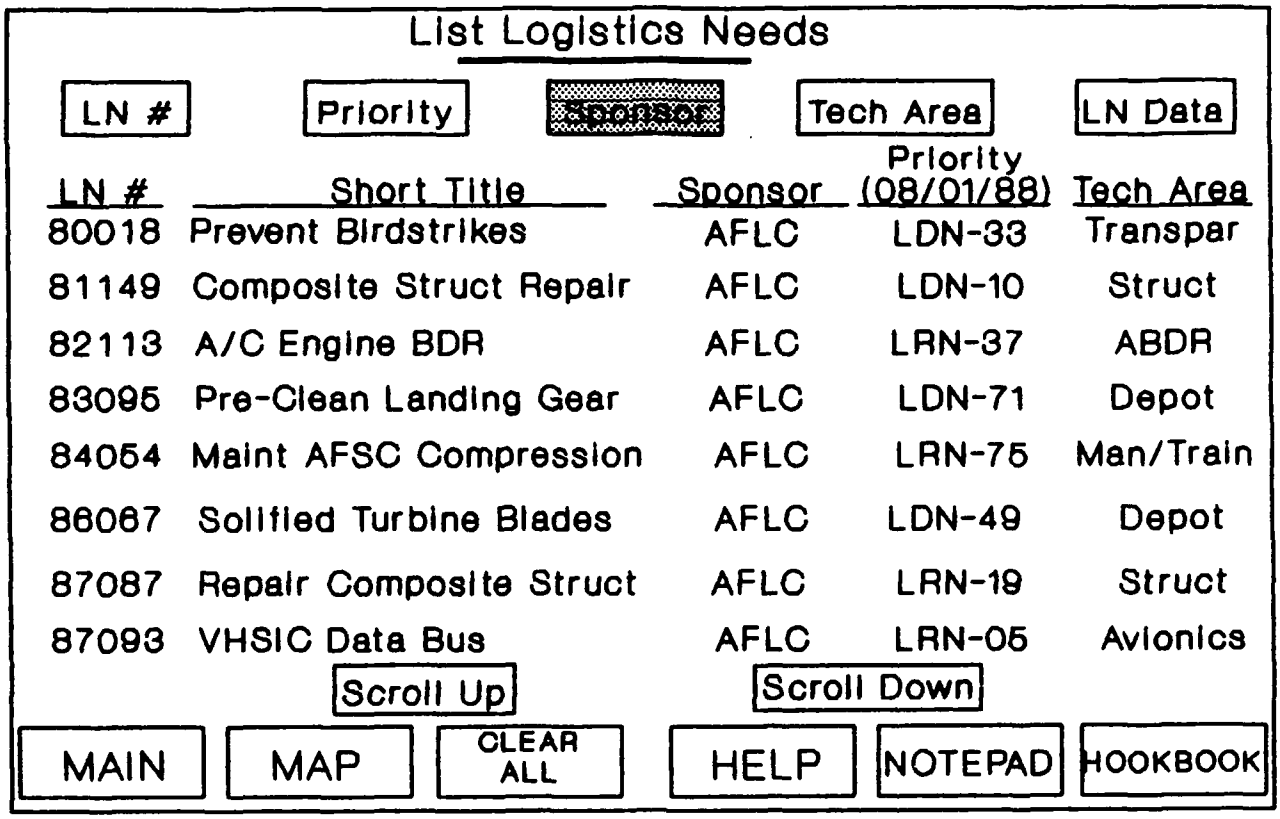


1. The result of selecting all LNs is this list of the LNs in priority order.

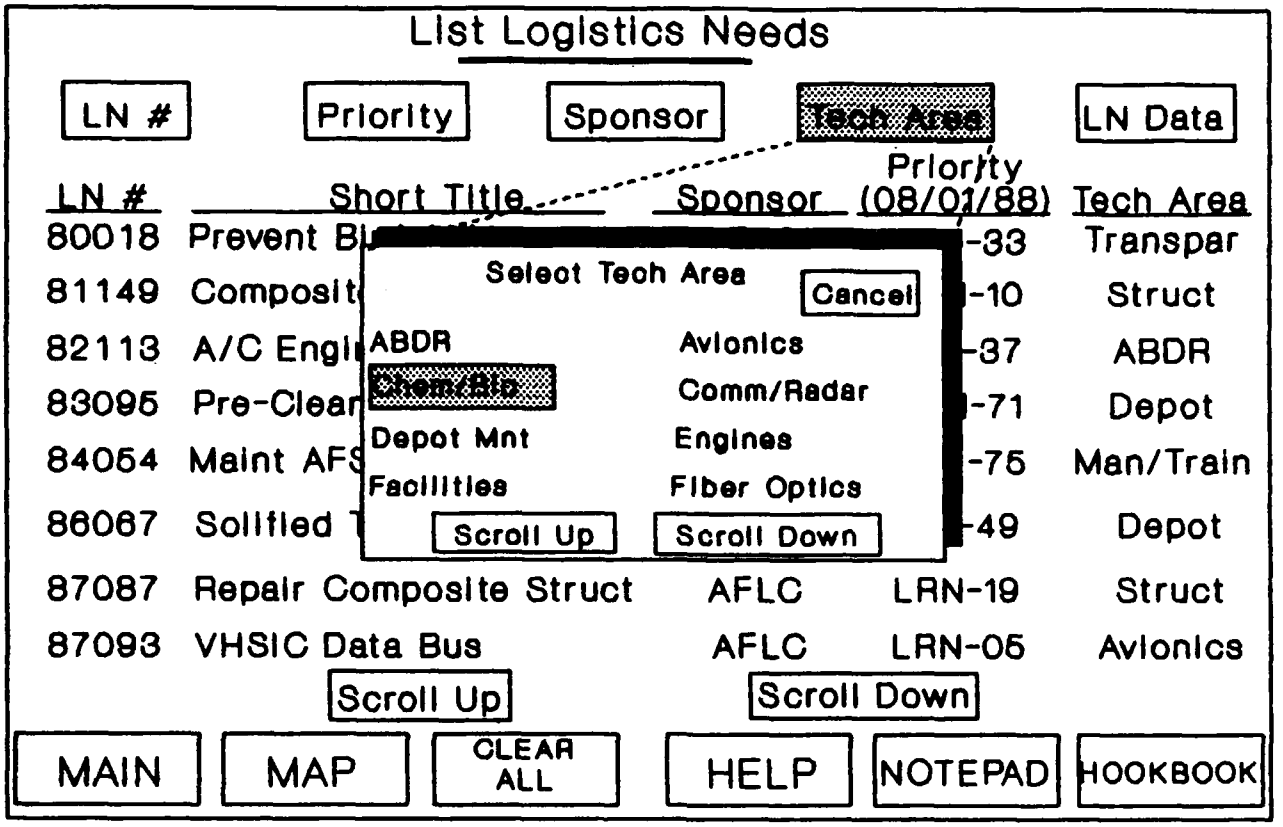
2. The user can still choose to see another priority order, or use any of the other functions.



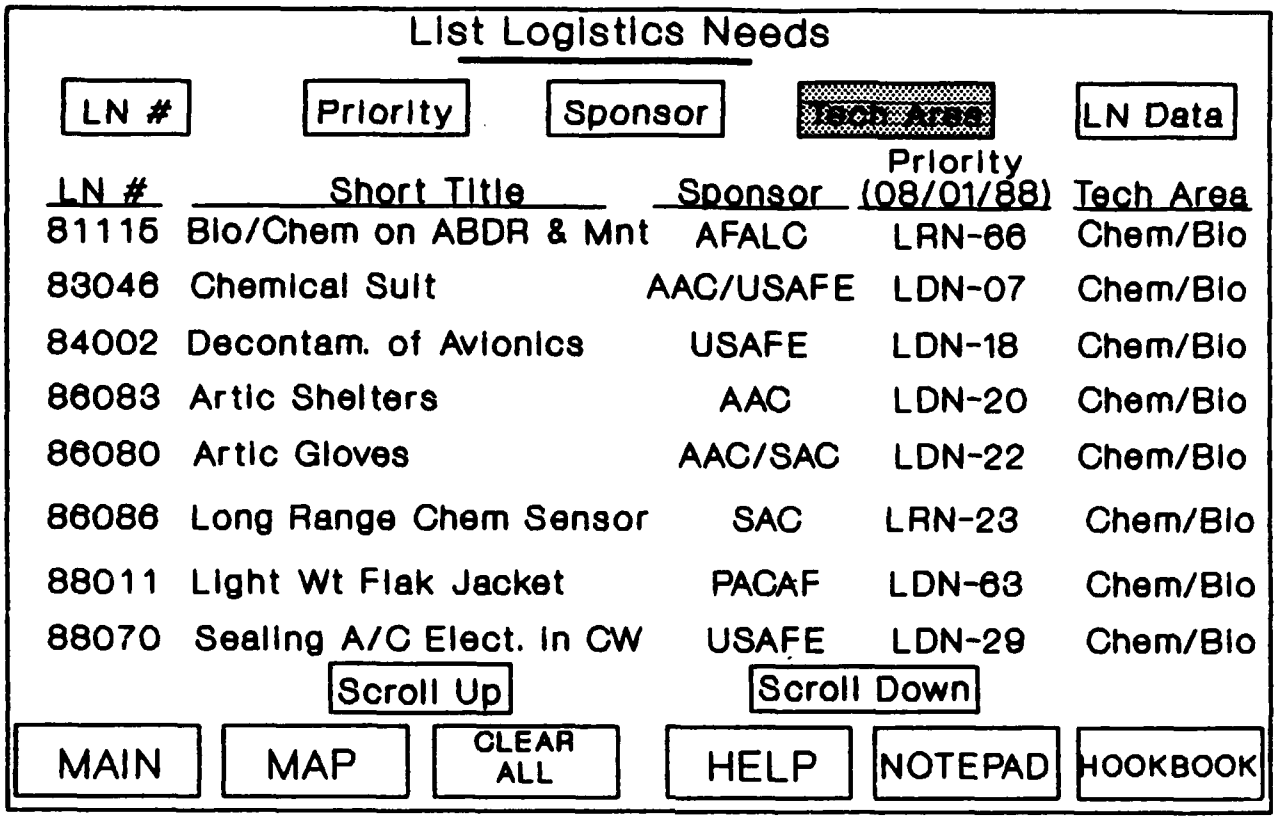
1. Selecting to see the LNs according to their sponsor produces a window from which the user selects a particular sponsoring organization.



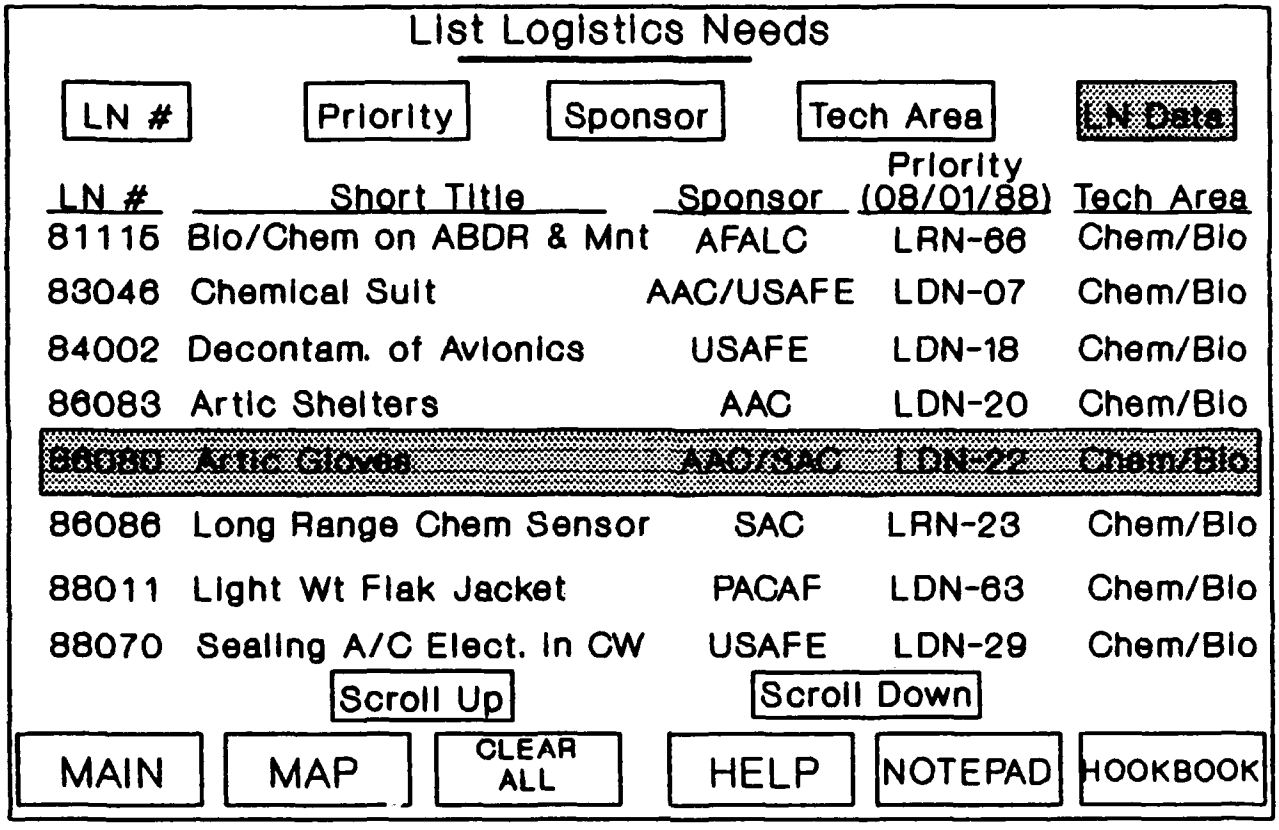
1. Having chosen to see the LNs sponsored by AFLC, the list is displayed by LN #.



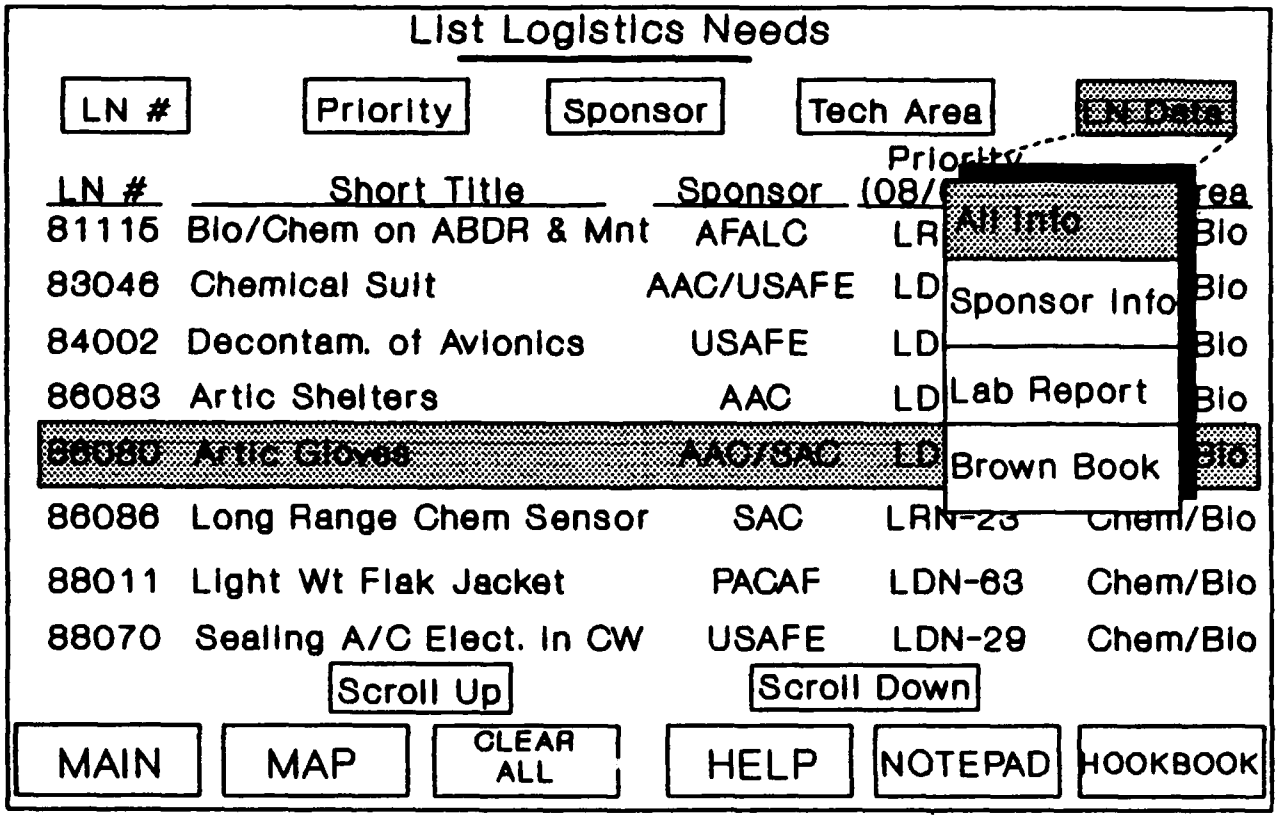
1. As with the other functions, selecting to view the LNs by their Technology Area produces a window of the available Technical Areas from which to choose.



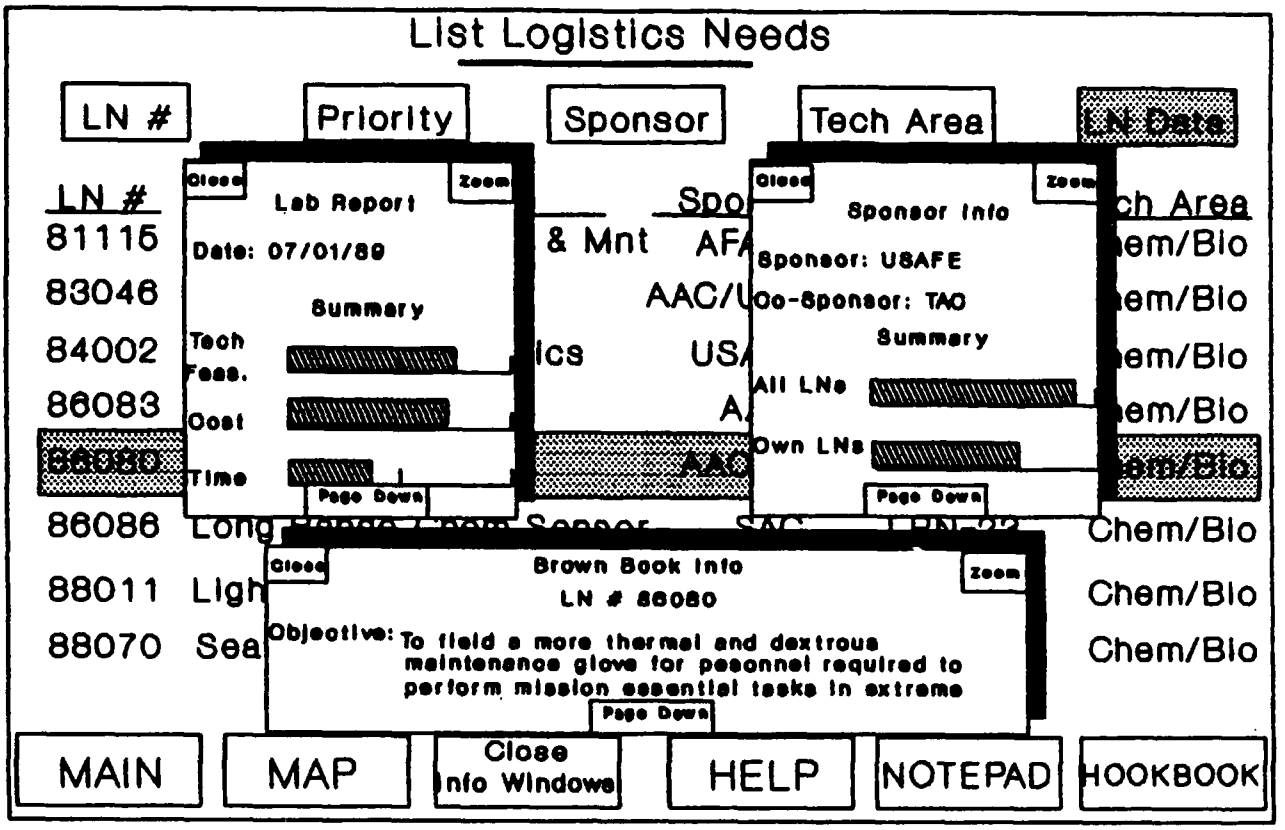
1. Having selected to see the LNs in the Chemical and Biological Technology Area results in this resulting display.



1. Selecting to see more data of an LN, the user next moves the horizontal bar to highlight the desired LN.



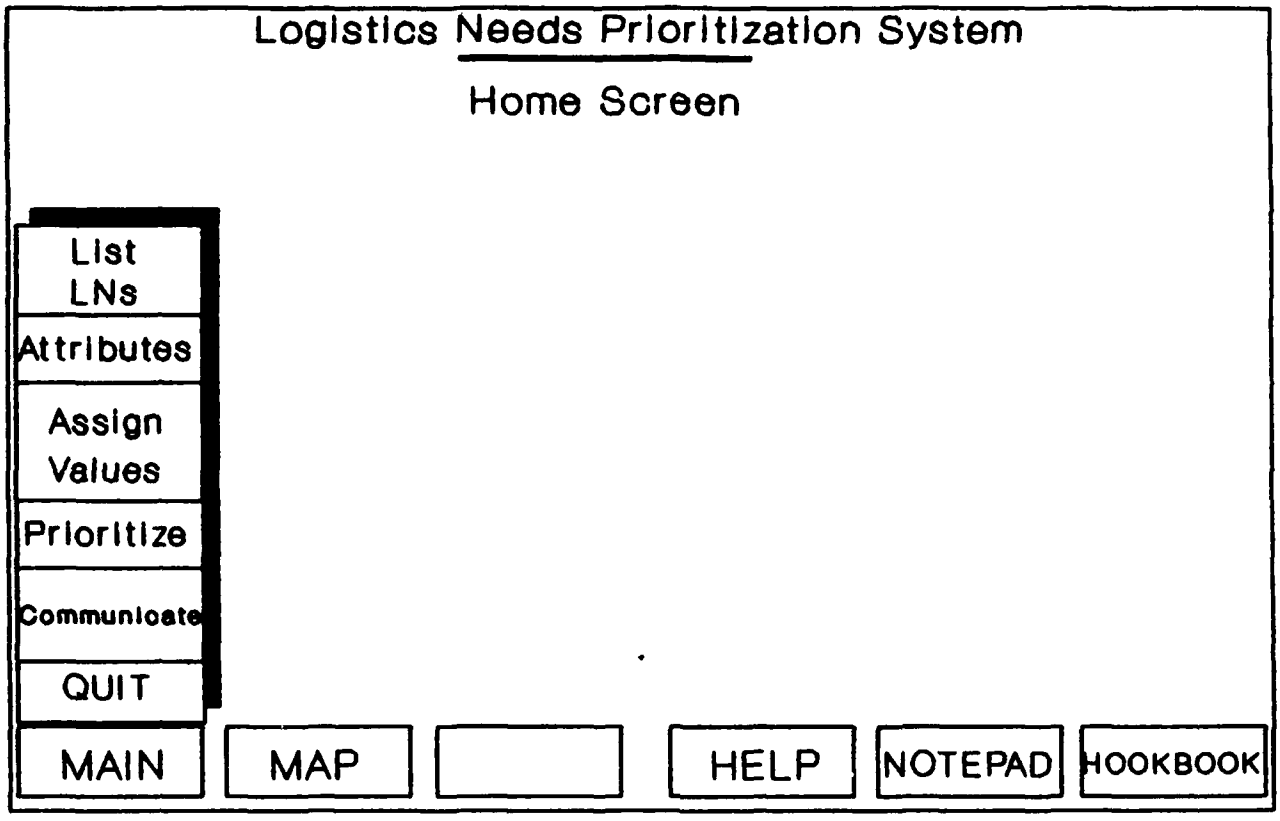
1. The user has a choice of informational displays to examine for the particular LN. Each option produces specific, detailed information from the indicated sources. The user has the option to examine all the information at once.



1. Having selected to see all information about the LN, three information windows are displayed.

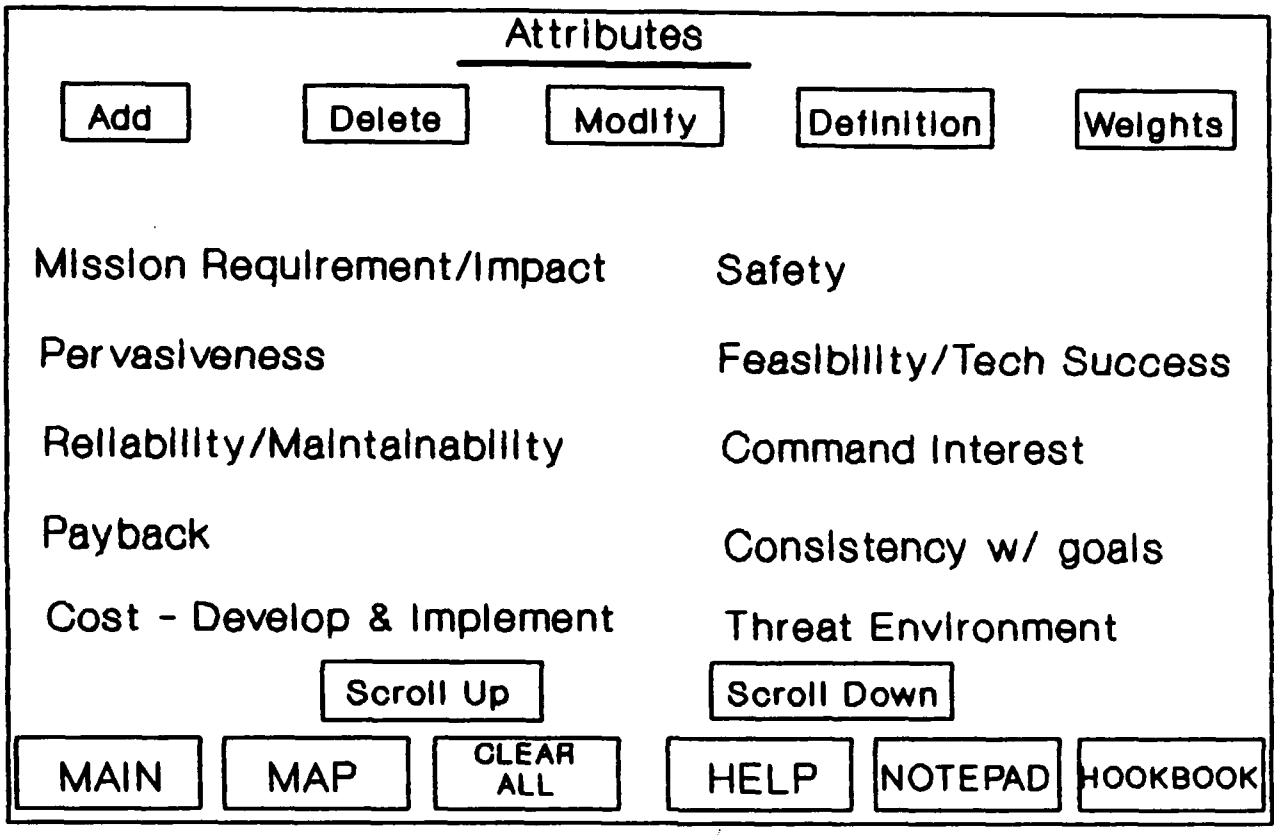
2. The user can move to any of the information windows, zoom them larger for easier reading, scroll through the entire amount of information available in each, or select to close any window.

3. The bottom-line Clear-All function is temporarily replaced with a function which would close all of the information windows at once.



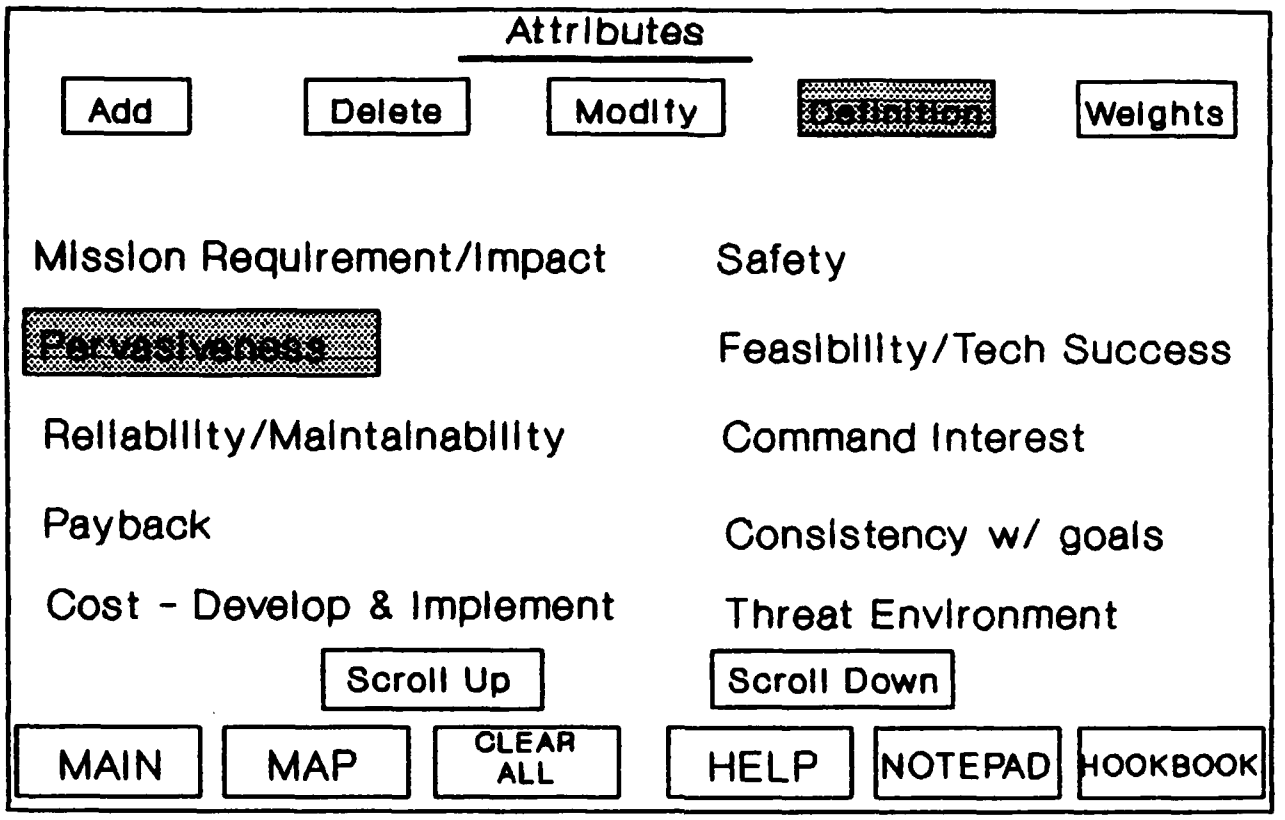
1. Closing all information windows and "Clearing-All" brings the user back to the Home Screen. Note: Although the Main functions are available throughout the system, for clearer explanation the storyboards show the user returning to the Home Screen between major processes.

2. If the user had desired, he could have invoked a Main function from the previous screen. The new function would be an "overlay" to the current process, not clearing it out. This is sometimes useful, for example when browsing through data, wanting to examine attributes or scores, and then come back again to the data.

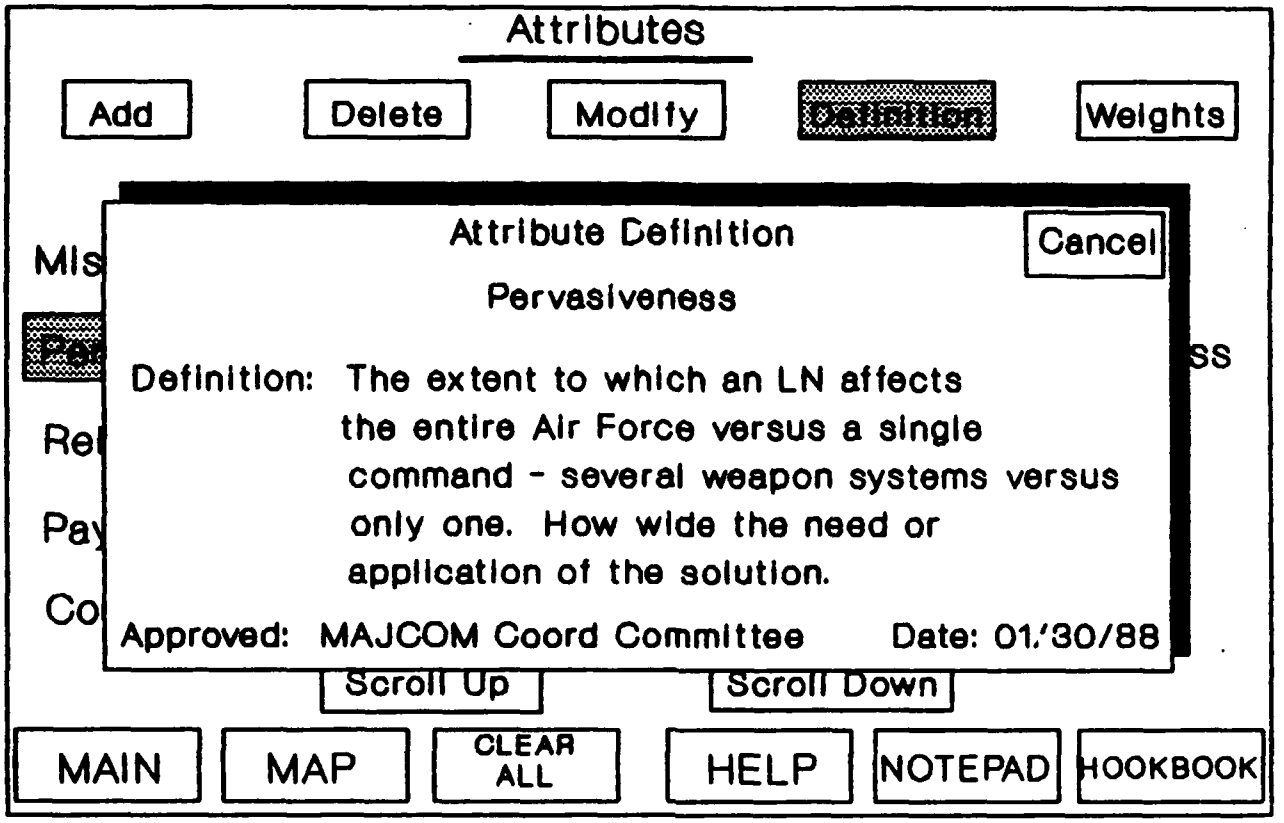


1. Selecting Attributes from the Main menu presents the user with a display of currently defined attributes within the system.

2. Top-row functions allow for editing, examining, and weighting the attributes.

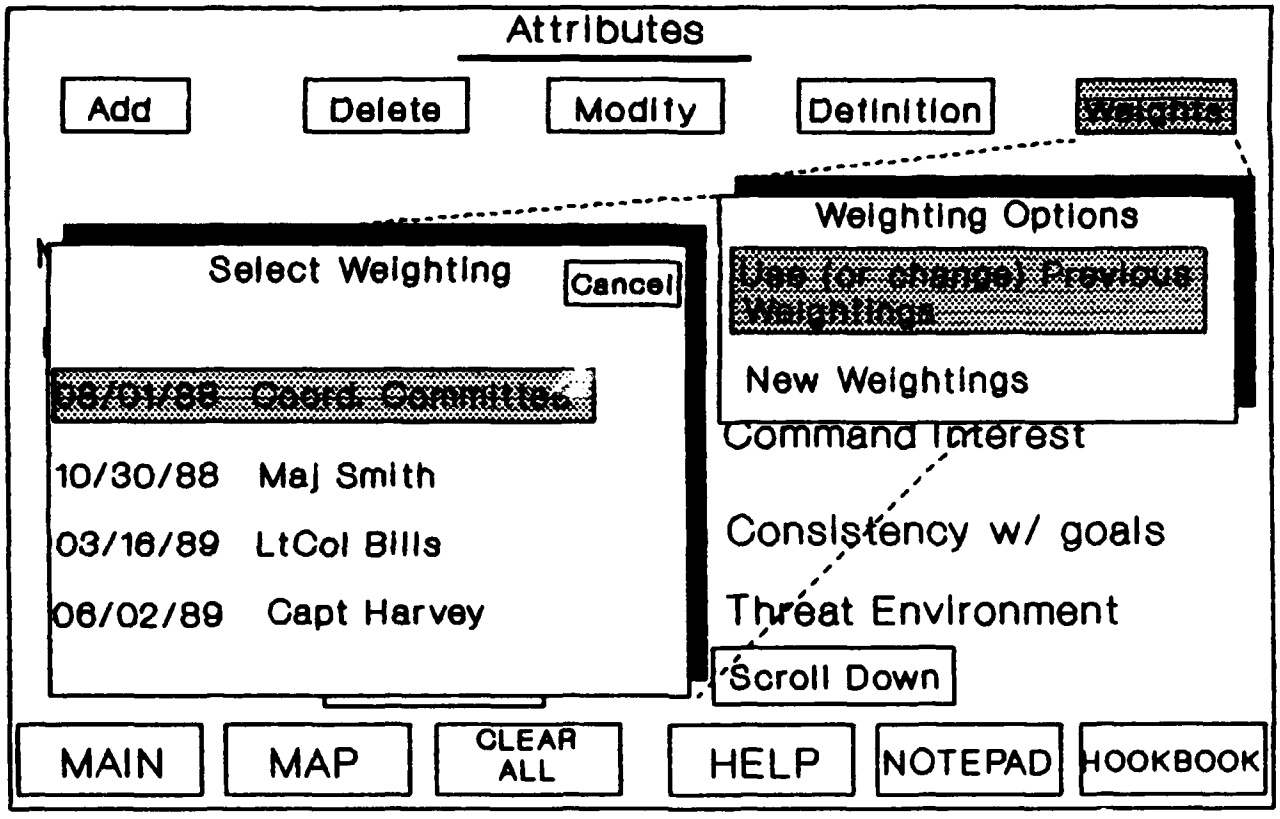


1. Selecting to see a definition of an attribute, the user next selects the specific attribute.



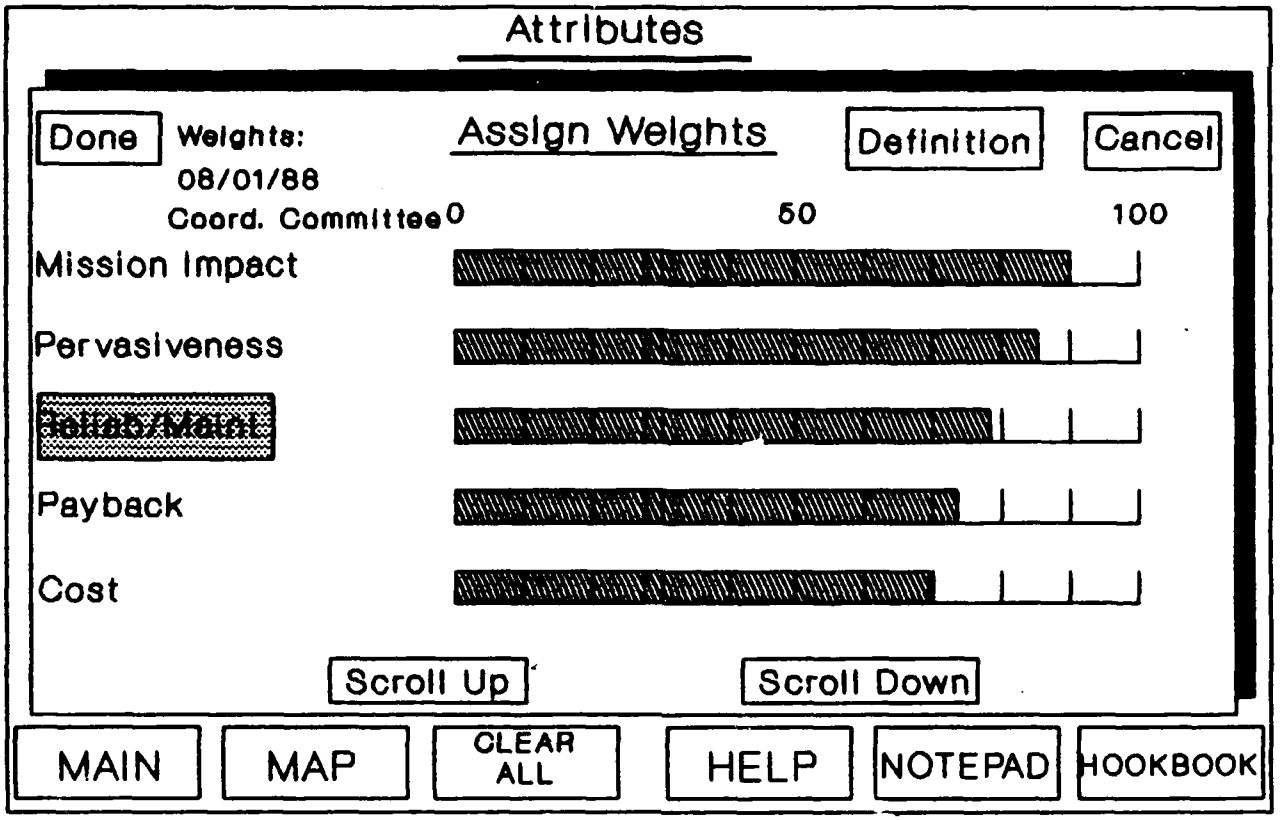
1. An attribute definition window is presented which contains the definition along with the approving agency and date of approval.

2. The add, delete,and modify functions present similar displays.



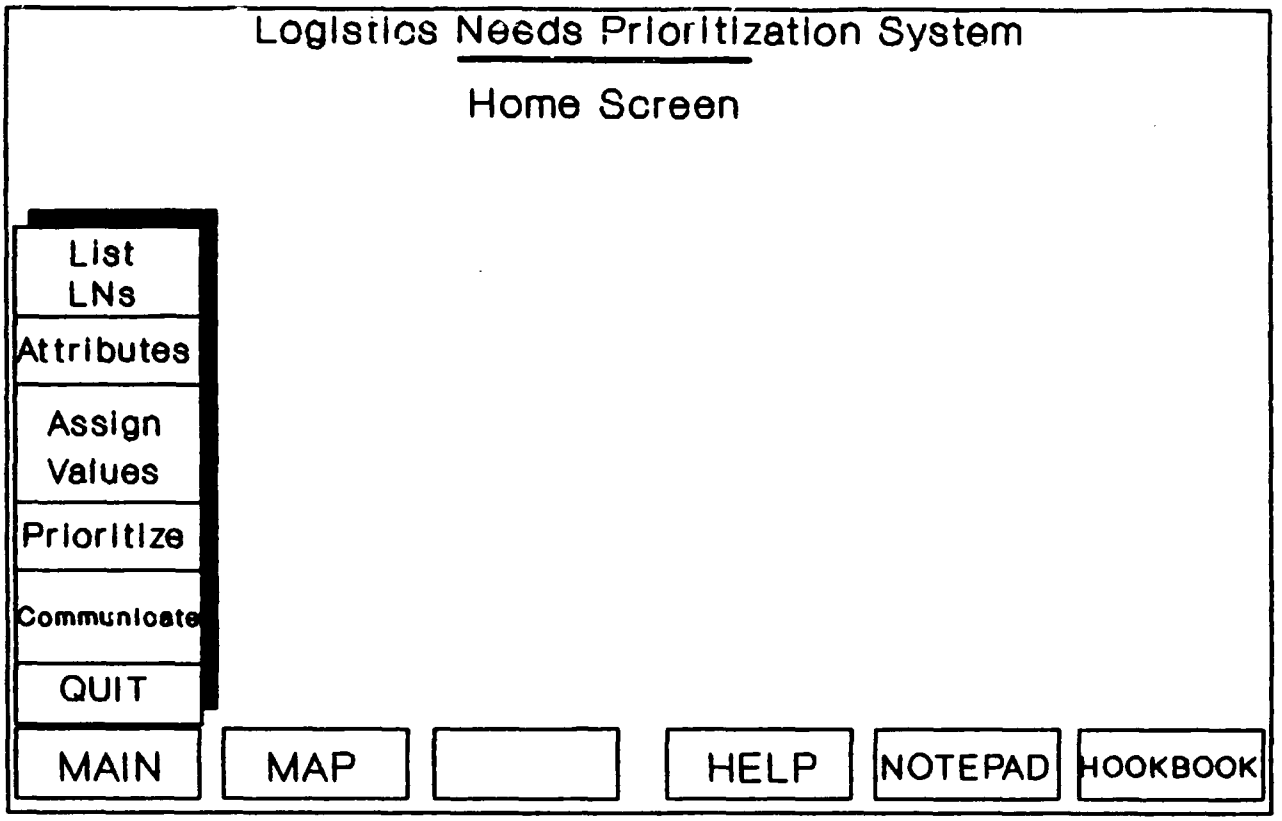
1. Selecting to assign weights to the attributes produces a window prompting the user to select to use a previously weighted set of attributes or to originate his own set of attributes and their weights.

2. Selecting to use a previous set of weights brings-up a window of options from which to choose.

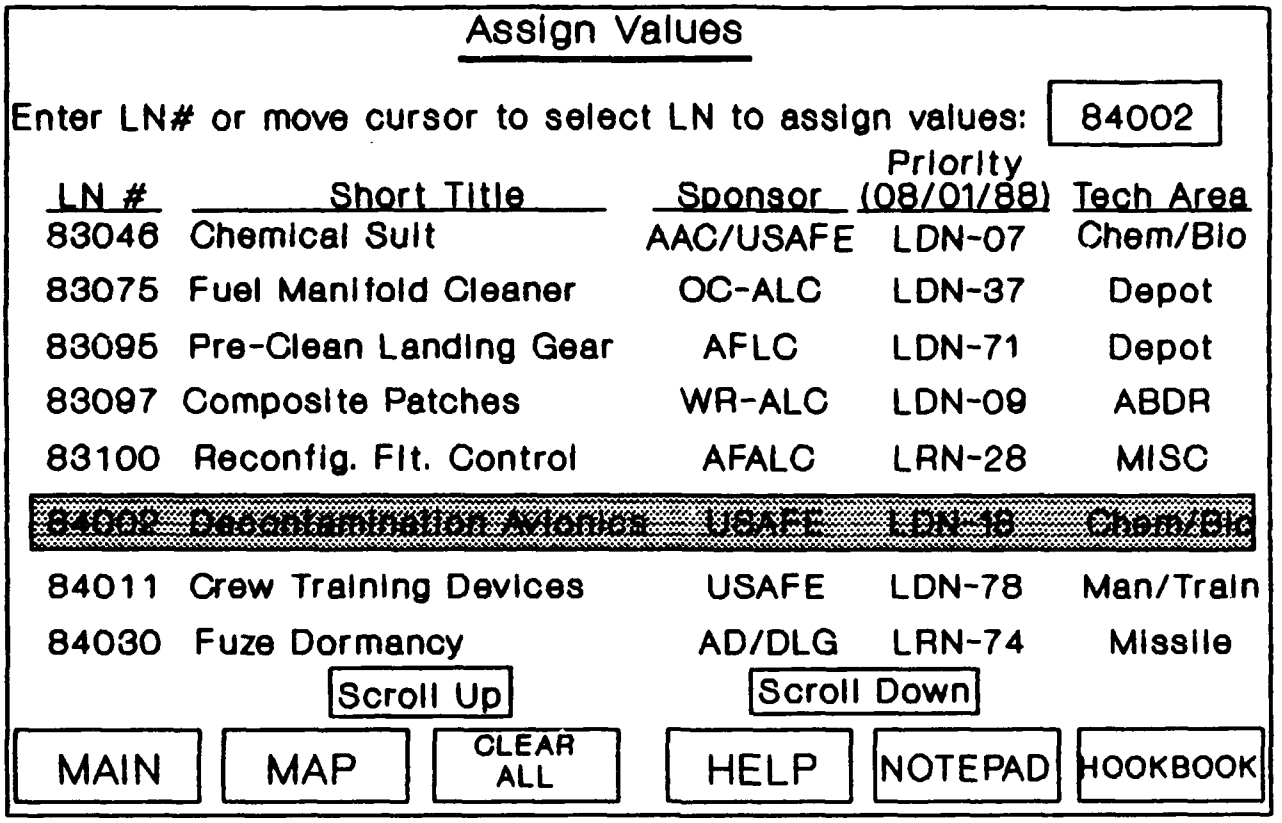


1. Having selected to start with a previously weighted set of attributes, the user sees the weights that had been assigned to the attributes. The user can change any of the weights as desired by highlighting an attribute and moving the horizontal bar.

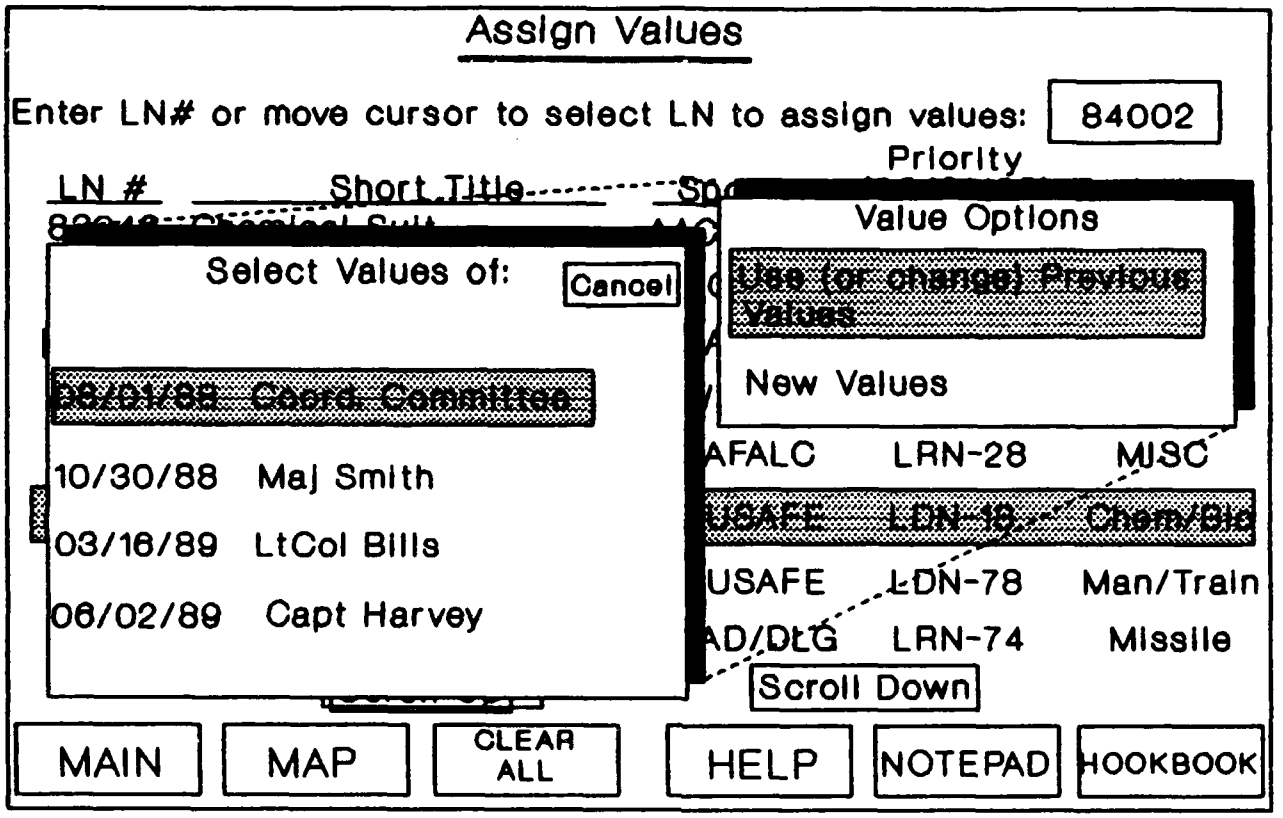
2. Completing the weightings (Done) saves the set of attributes along with their weights under the user name and session date.



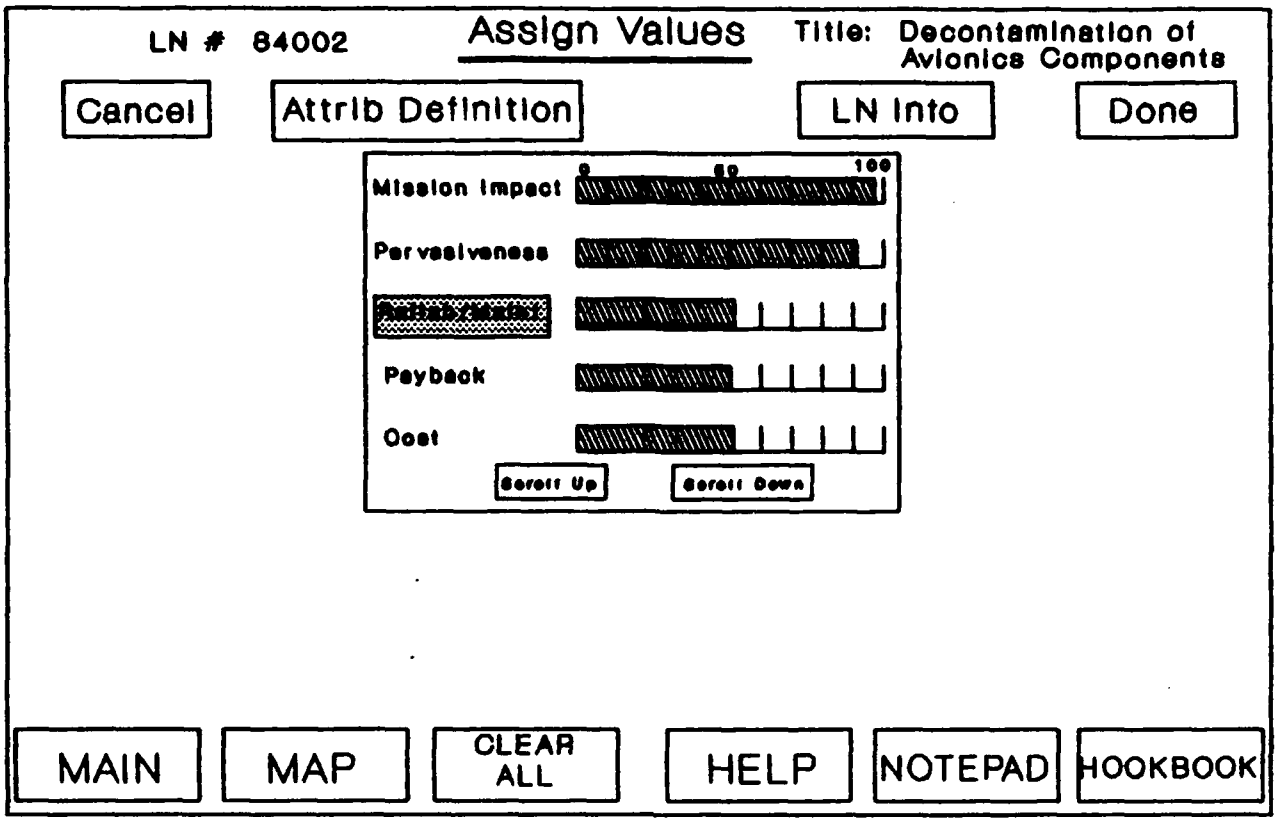
1. Again, Clear-All returns the user to the Home Screen.



1. Selecting to Assign Values from the Main menu, the user next selects an LN to score.

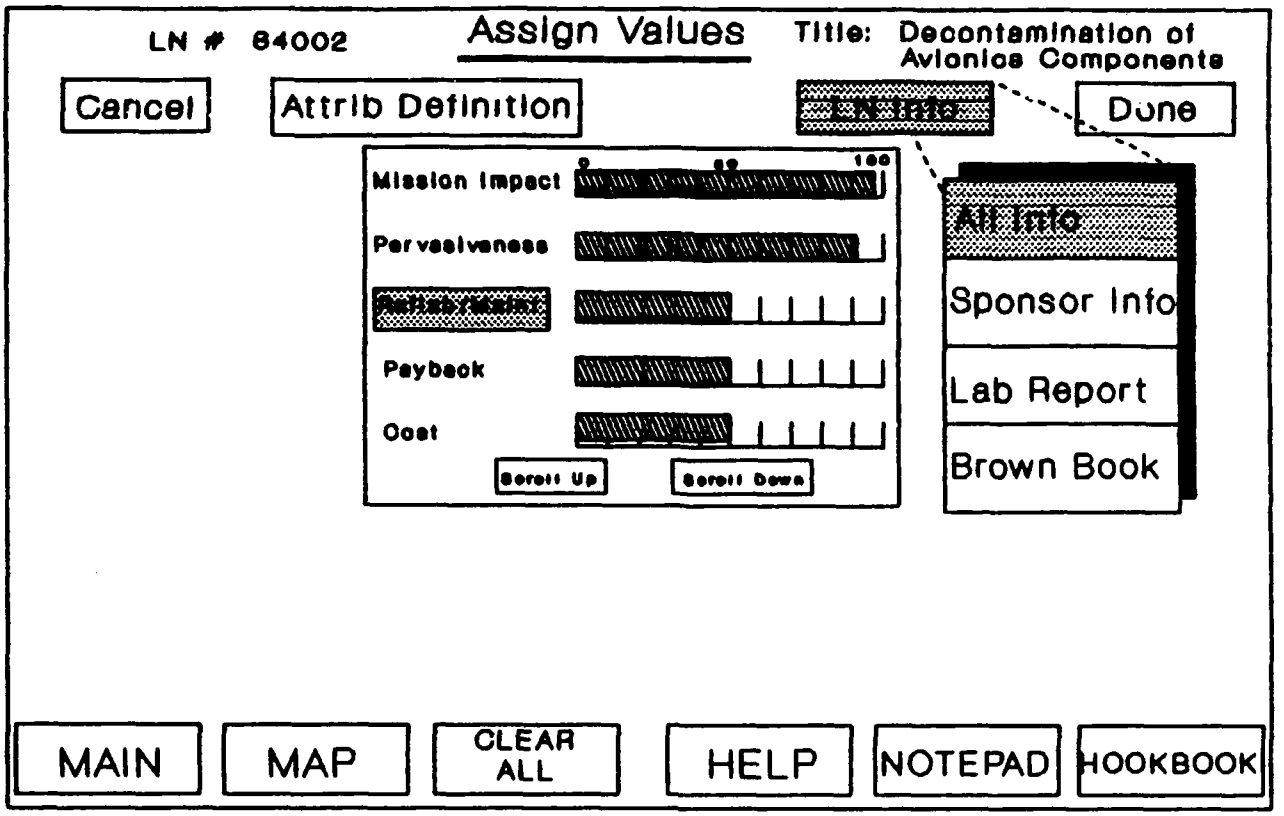


1. As with the attributes, the user can select to begin with the values assigned in a previous ranking session or can choose to score the LNs independent from previous efforts.

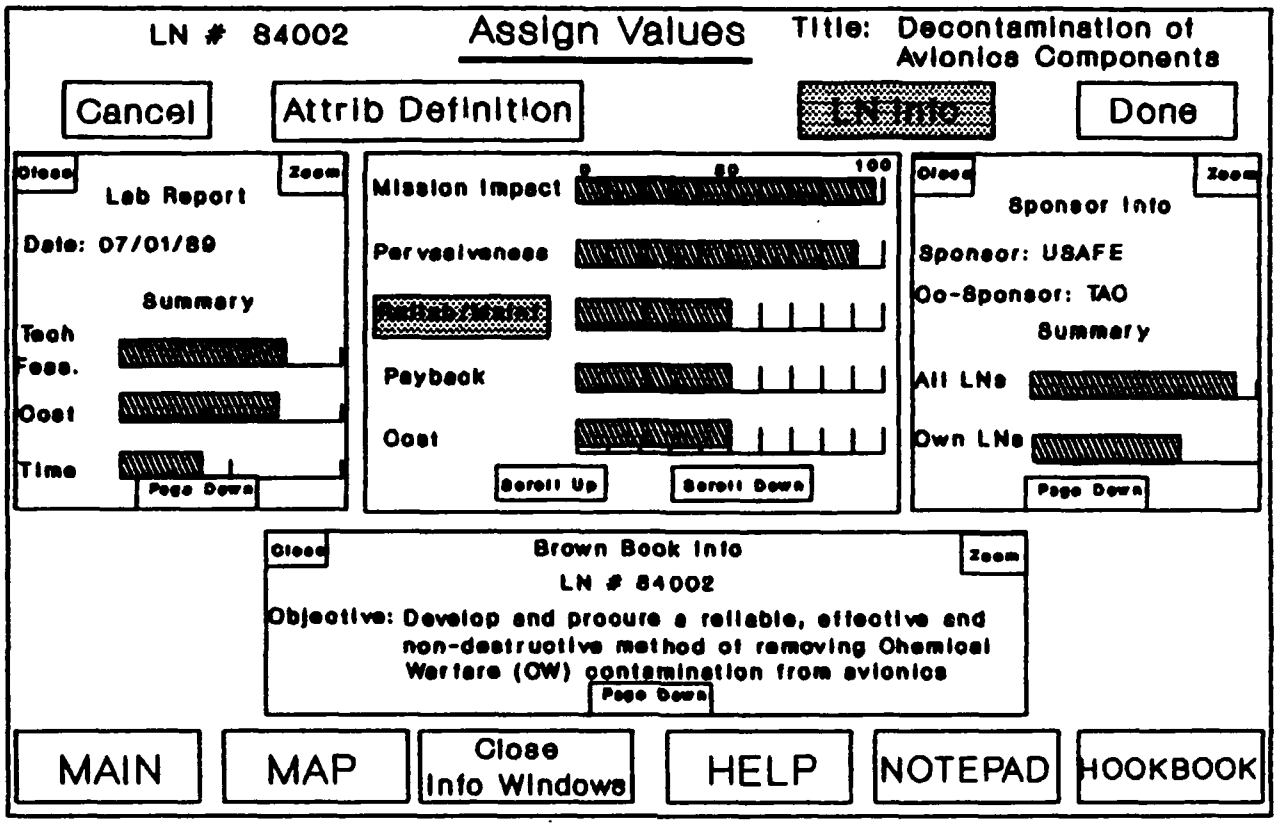


1. A scoring window is displayed in which the user assigns a value to each attribute. The horizontal bar for each attribute is originally set at 50 to force the user to go up or down from there in his scoring.

2. The top-line functions give the user the attribute definitions and the option to examine the available information concerning the LN.



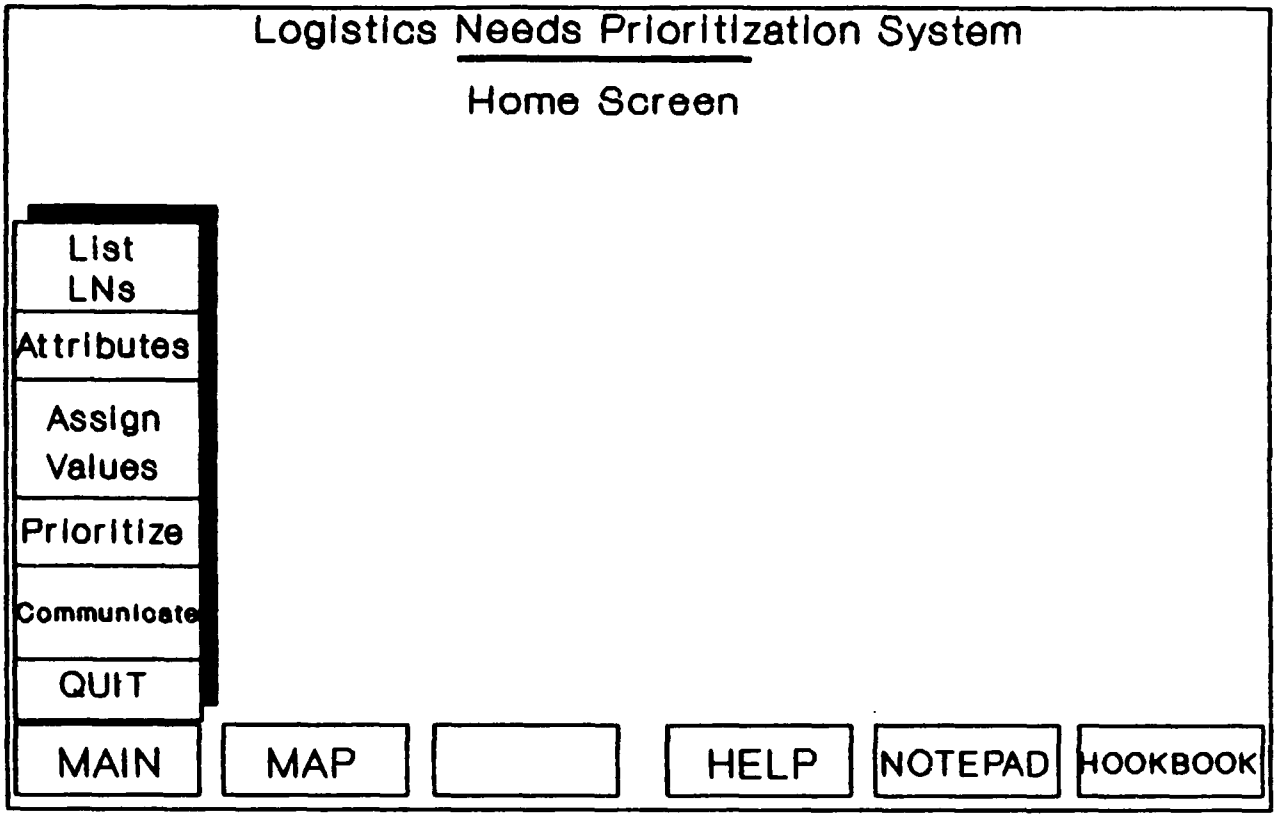
1. Selecting to see the LN information presents the user with the option of seeing all of the information or only a specific piece of information.



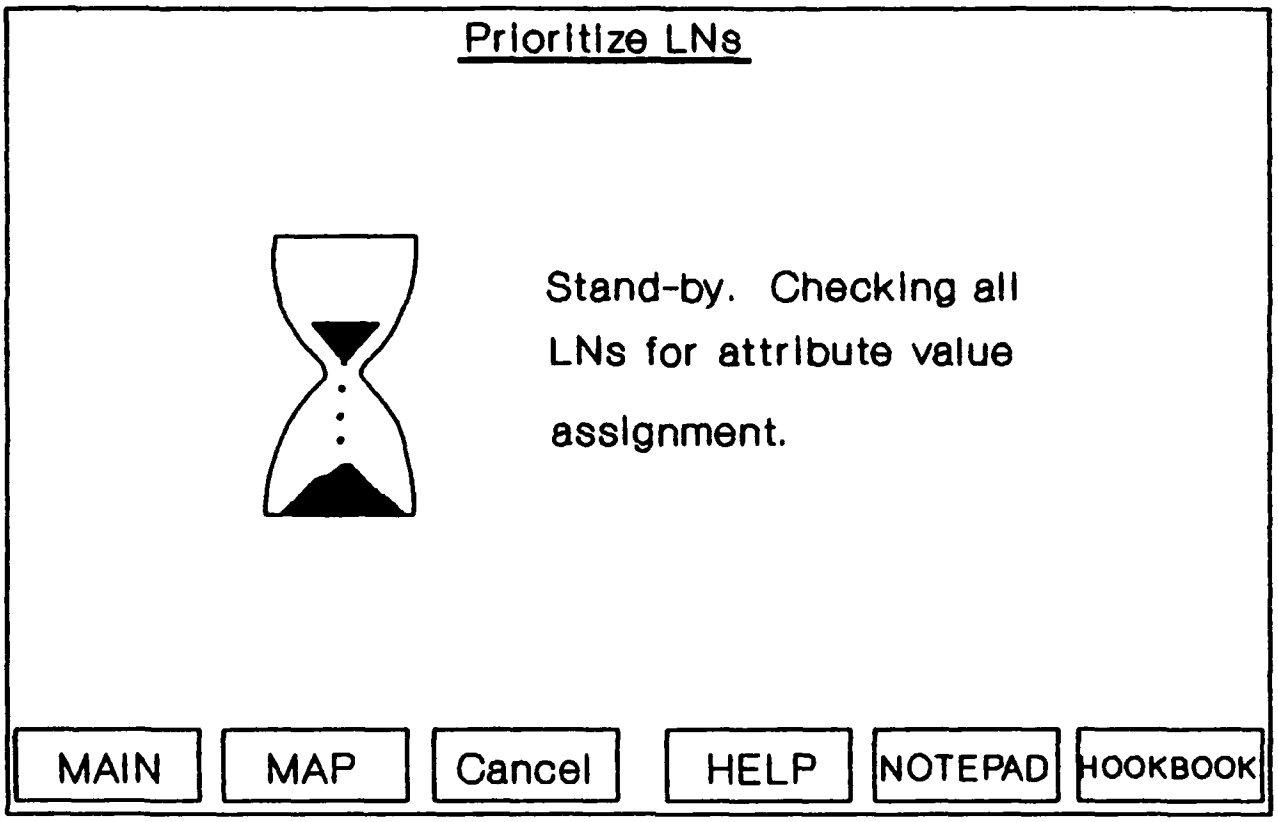
1. Although busy, this screen presents the available information to assist the user in scoring the attributes for the LN.

2. The user can move between windows, zooming each to see more data. Each window can be closed individually, or the bottom-line Close Information Windows will close all three windows at once.

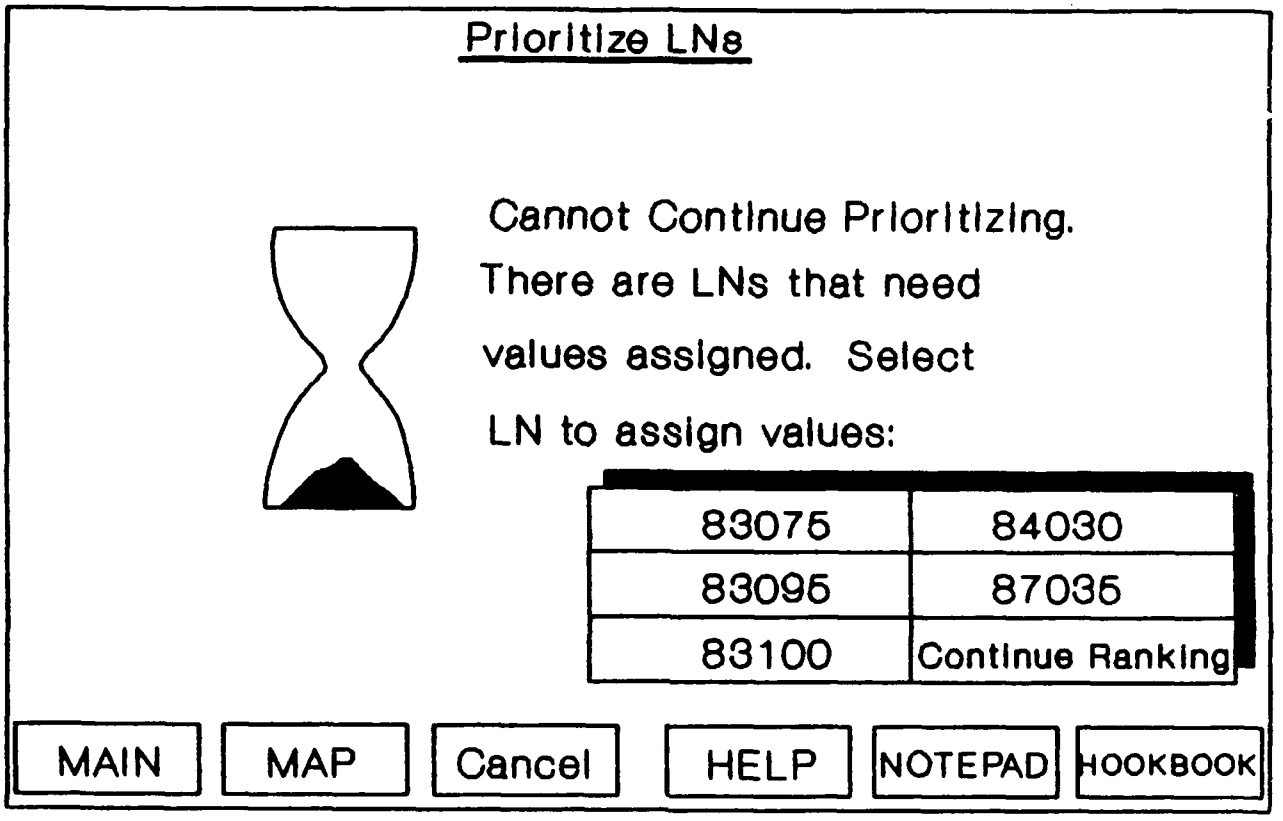
3. After assigning values for all attributes, the user selects Done and those scores are saved.



1. Again, Clear-All returned the user to the Home Screen.



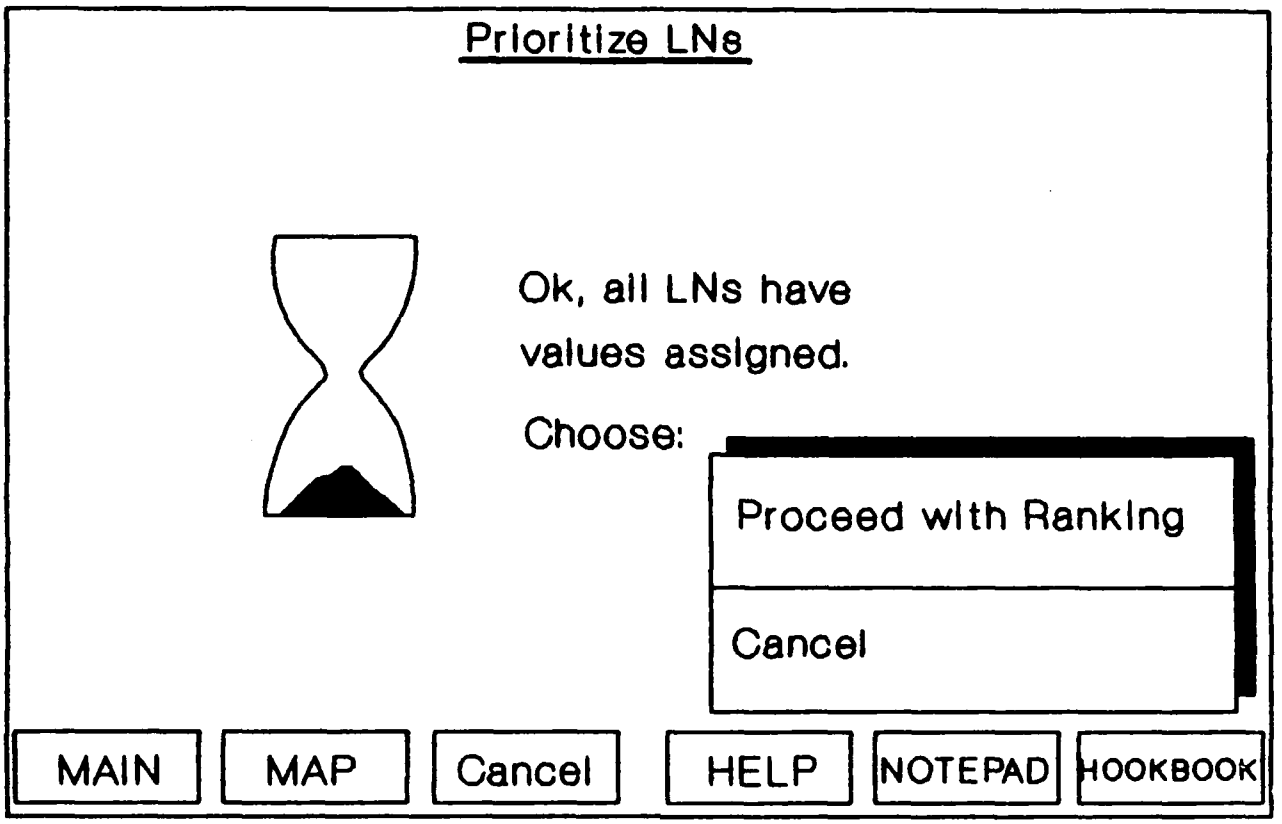
1. Selecting to Prioritize the LNs causes the system to check if all LNs have values assigned to them.



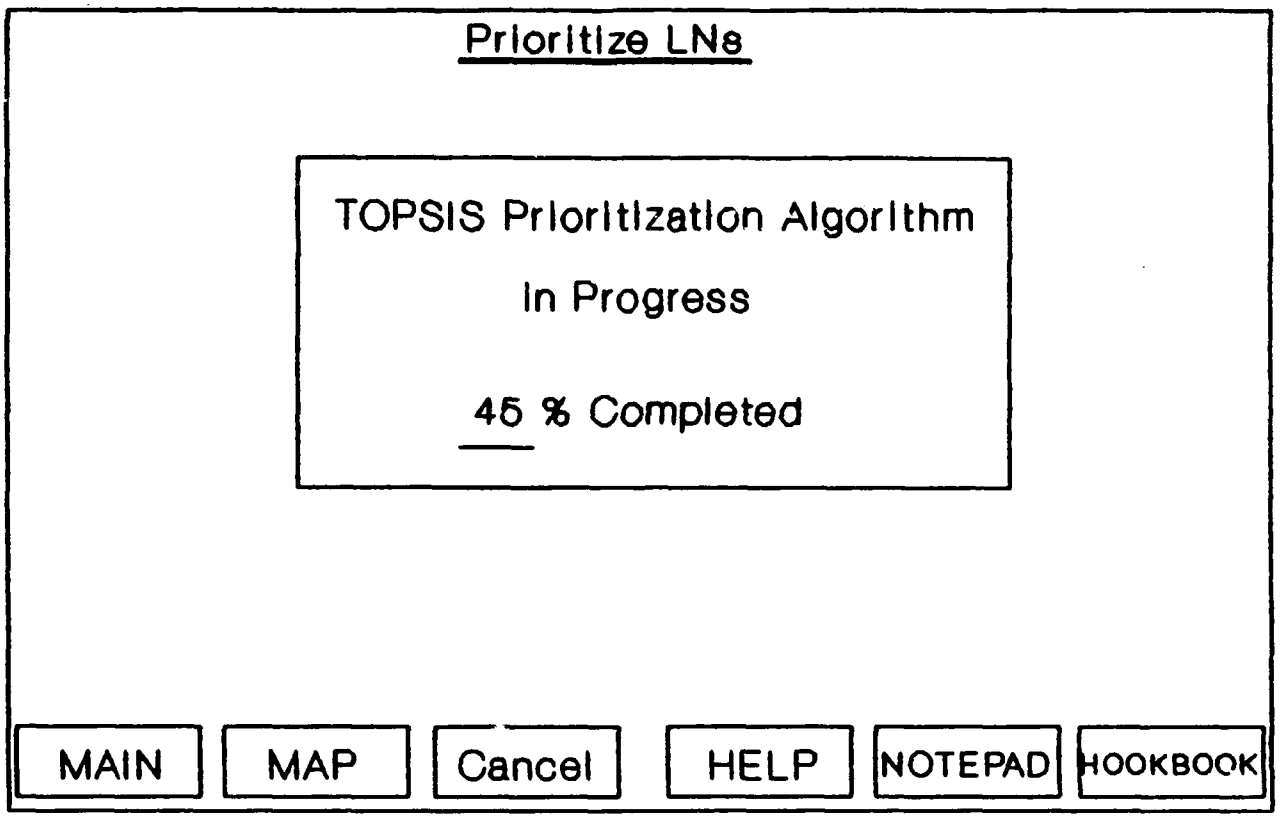
1. If there are LNs which have not been scored, the system lists those LNs and prompts the user to assign values for them.

2. Selecting an LN from the menu takes the user to the Assign Values function of the system.

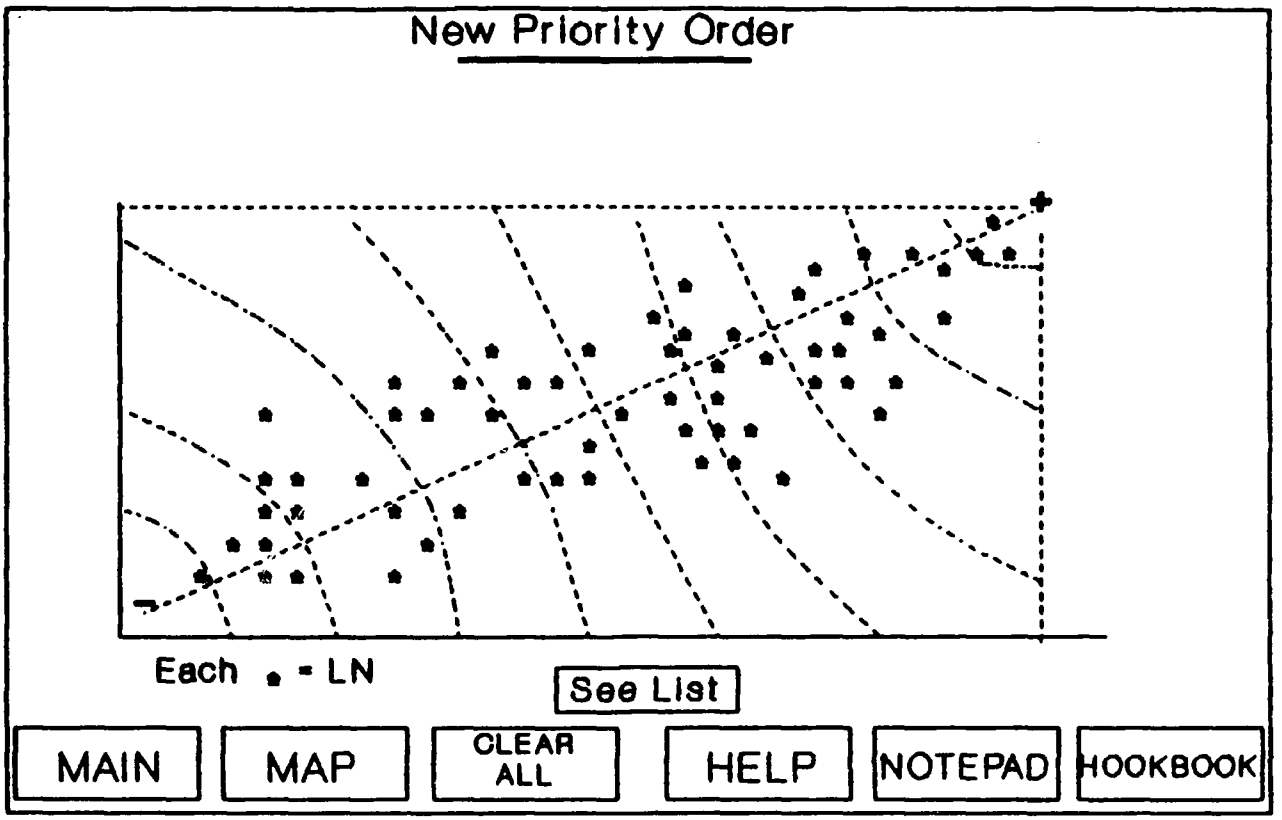
3. The user can choose to continue the prioritization without assigning values to all LNs. This could be useful when ranking a sub-list of the LNs. The system would then ignore any unscored LN.



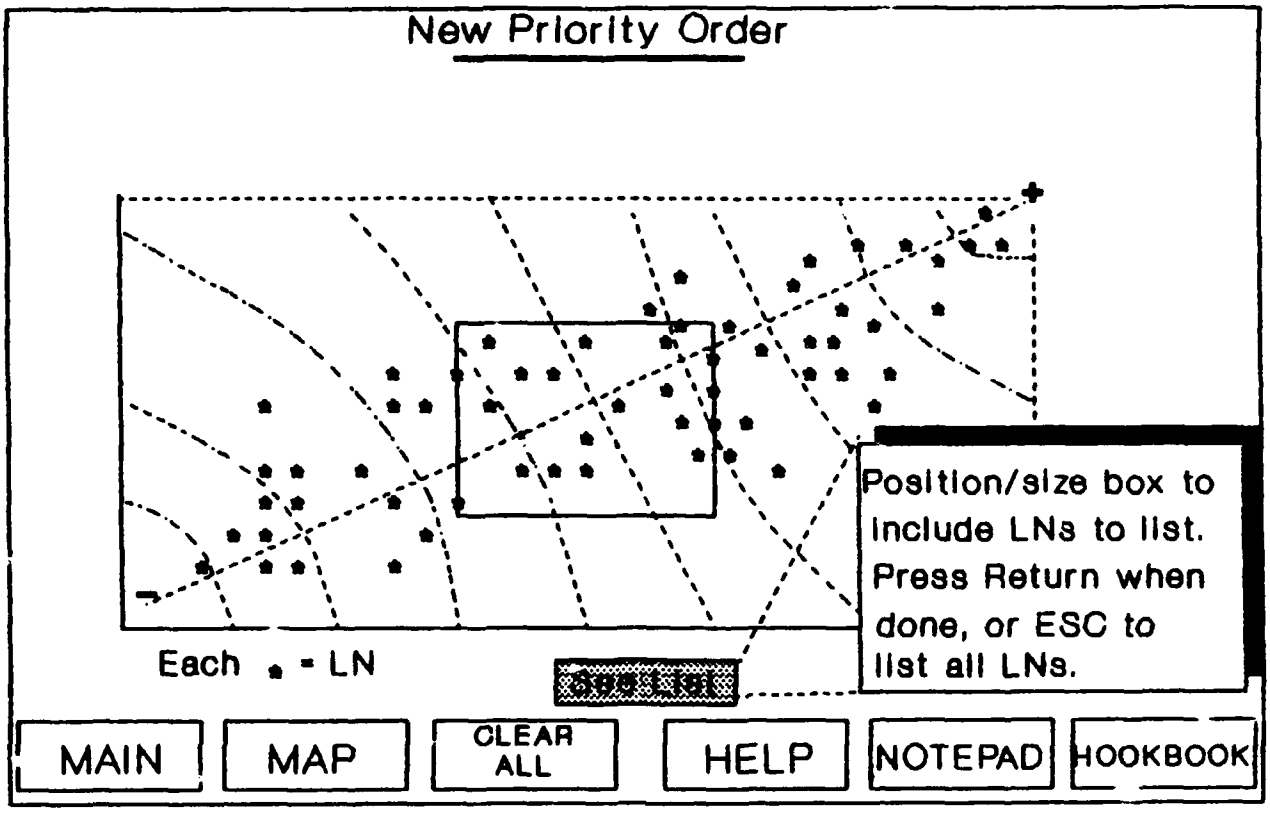
1. If all LNs were found to be scored, the system prompts the user to proceed or stop the ranking process.



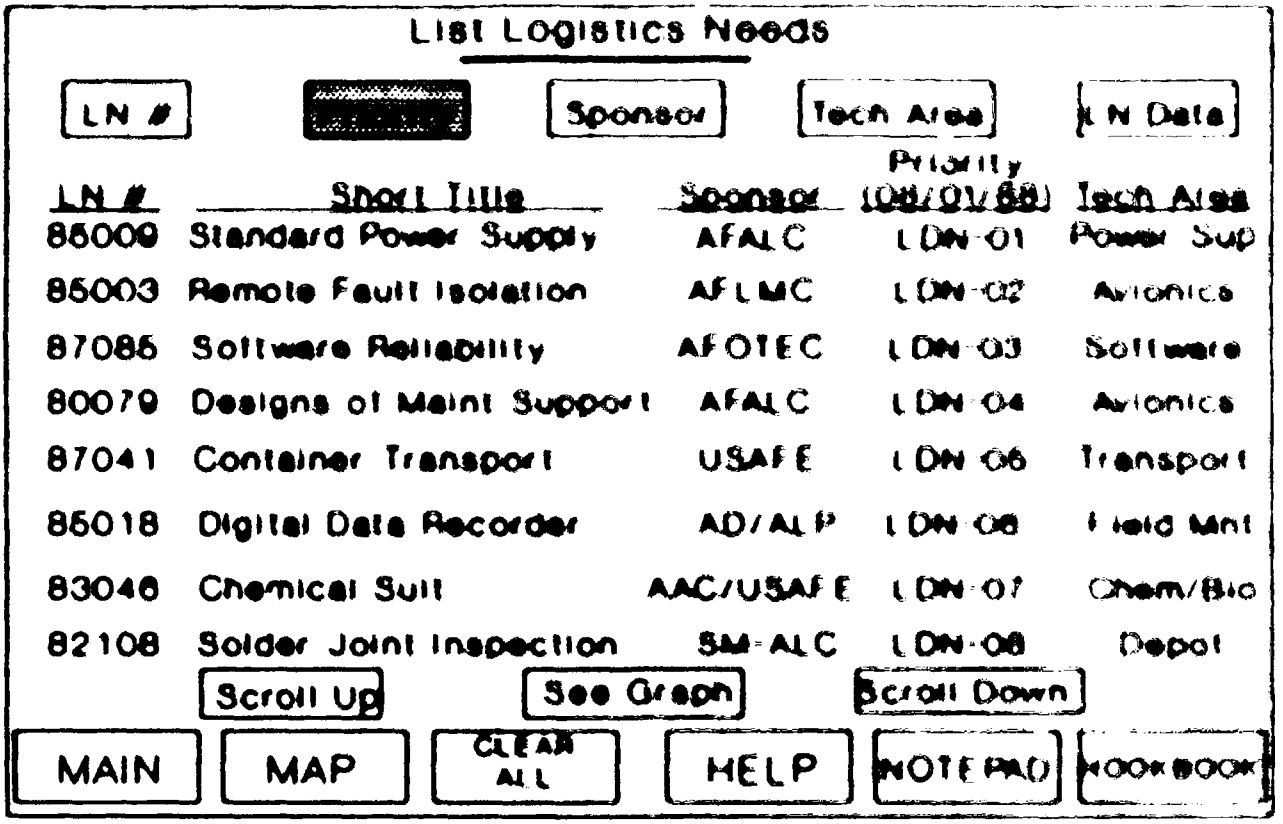
1. While the system is computing the new LN priority order, it keeps the user informed as to its progress through the calculations.



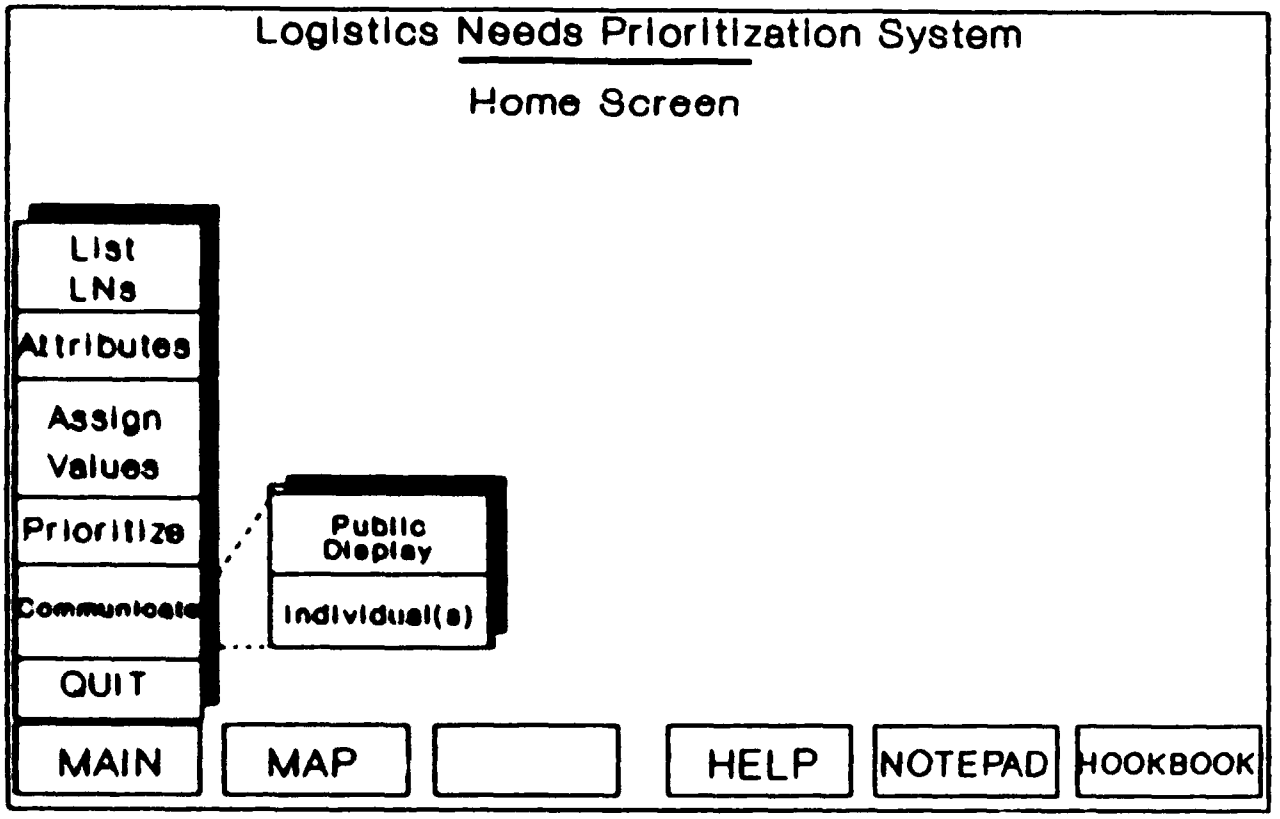
1. The new priority order is presented graphically. The user can choose to see a prioritized list of all or a part of the LNs.



1. The user selects all or a portion of the LNs to examine in a rank-ordered list.

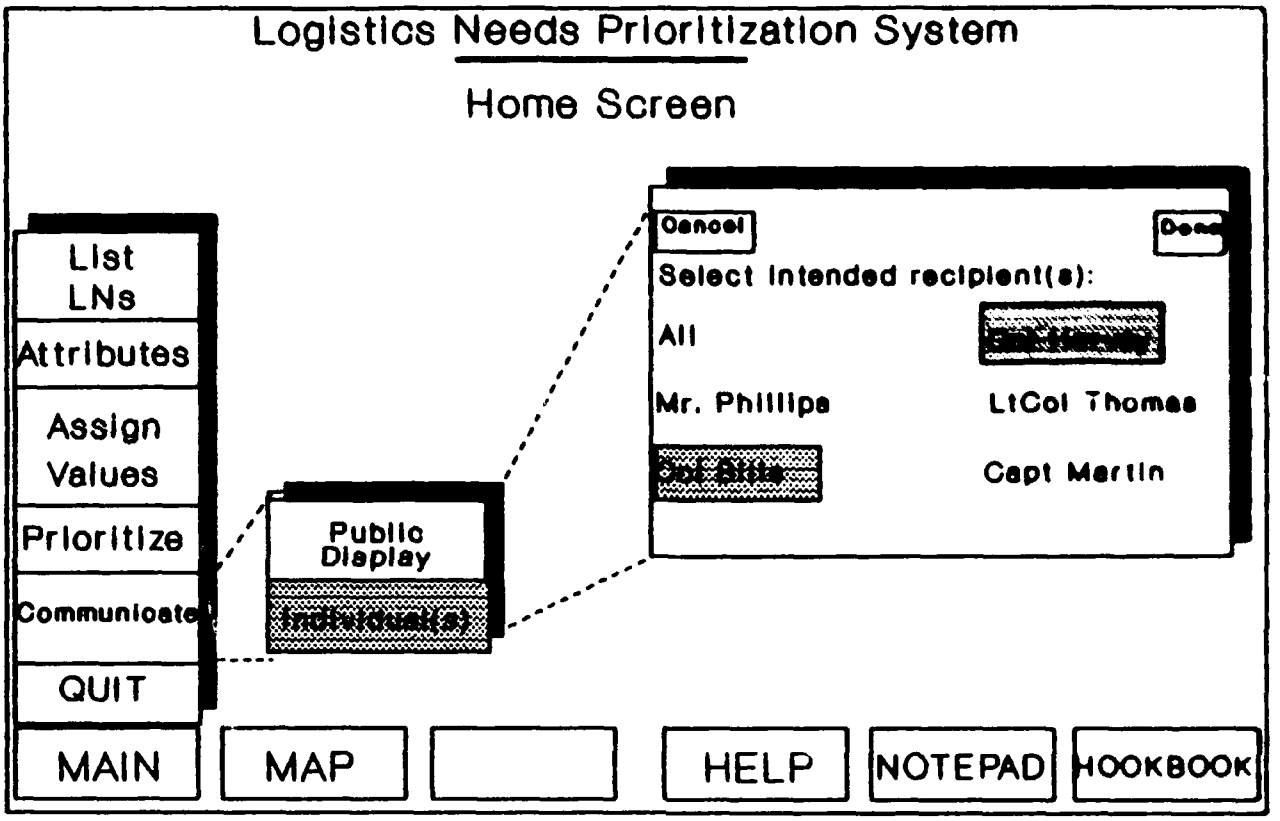


1. The user is then presented the LNs in their new priority order and is back in the List Logistic Needs section of the system.



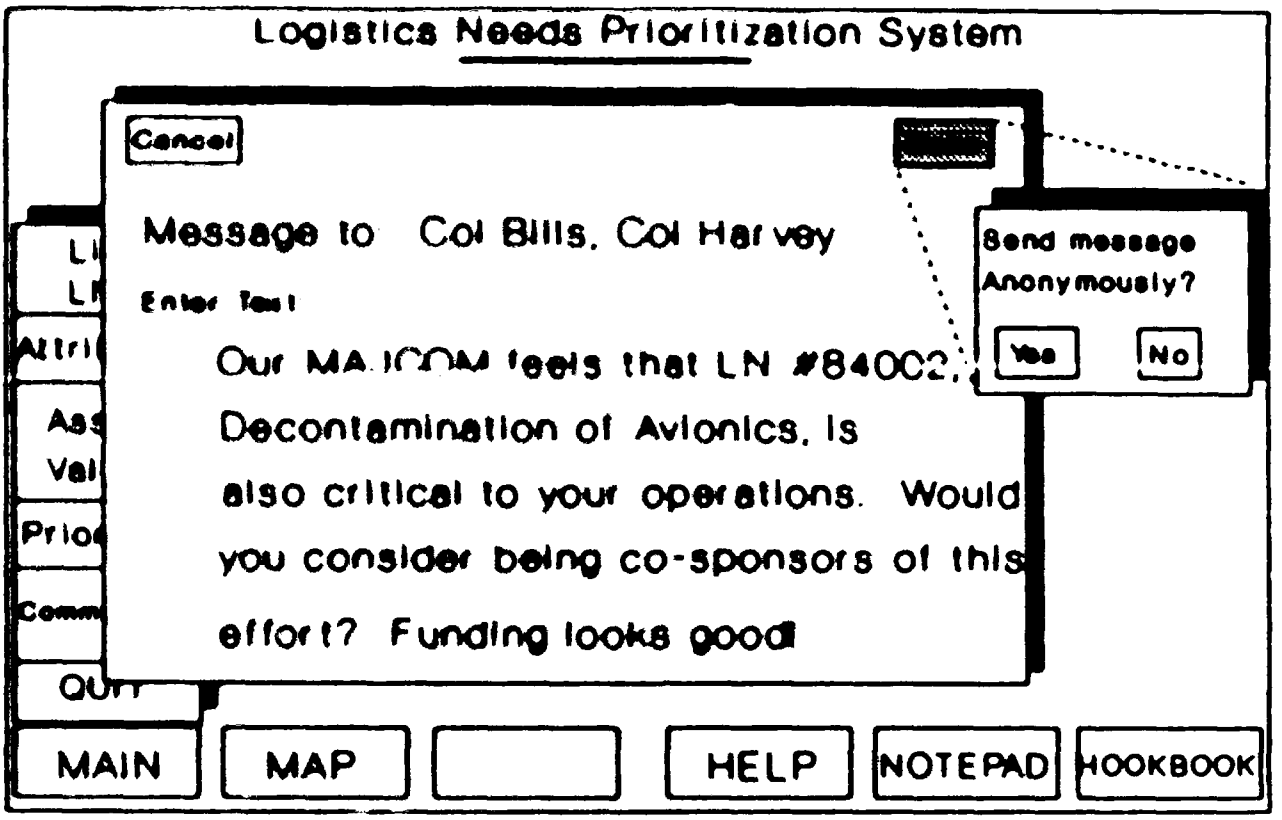
1. Having returned to the Home Screen and selecting the Communicate function from the Ma n menu, the user can select to send a message to other individual(s) or to the public display screen.

2. As with any of the Main functions, the user can select to send a message from any point in the system.



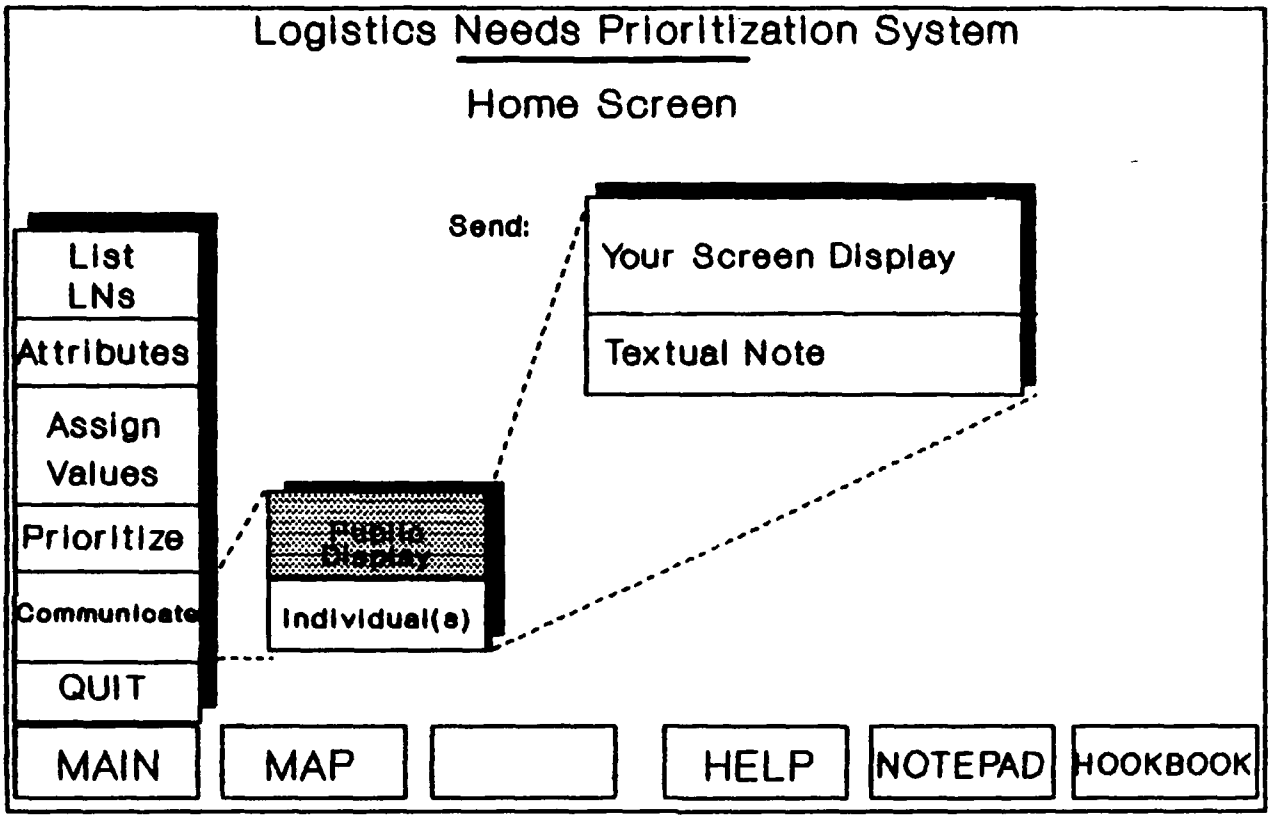
1. Selecting to send a message to an individual, a window presents a list of users associated with the system.

2. The user selects the intended recipient(s).



1. The user types the message in the message box which indicates the person(s) who receive copies of the message.

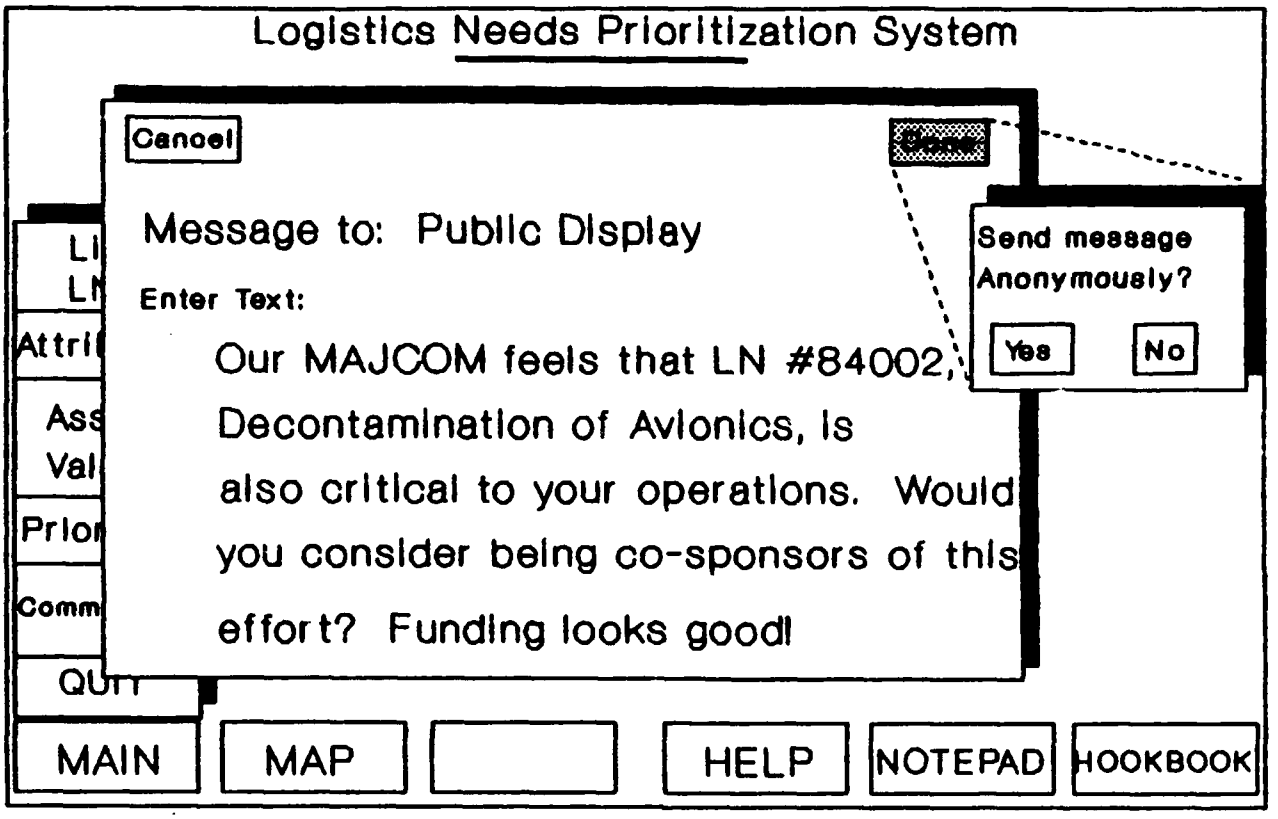
2. When the message is complete, the user selects Done and then has the option of sending the note anonymously or not.



1. If the message is intended for the public display, the user can choose to send a text message or to project his individual screen image onto the public display.

2. The option to project an entire screen display would be useful for showing the group members a particular bit of knowledge gathered from the data without requiring each individual to perform the steps of retrieving that information on their own.

3. A facilitator (chauffeur?) would assist in administering access to the public display.



1. Like a message to individuals, a message to the public display can be be sent anonymously if desired.

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; Distribution unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AFIT/GOR/ENS/90M-16	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION School of Engineering	6b. OFFICE SYMBOL (If applicable) AFIT/ENS
6c. ADDRESS (City, State, and ZIP Code) Air Force Institute of Technology Wright-Patterson AFB OH 45433	7a. NAME OF MONITORING ORGANIZATION 7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION AFOLTA	8b. OFFICE SYMBOL (If applicable) AFLD/LTD
8c. ADDRESS (City, State, and ZIP Code) Wright-PAtterson AFB OH 45433	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER 10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification) DESIGN OF A GROUP DECISION SUPPORT SYSTEM FOR PRIORITIZING AIR FORCE LOGISTICS NEEDS (U)	
12. PERSONAL AUTHOR(S) Richard M. Schooff, B.S., Captain, USAF	
13a. TYPE OF REPORT MS Thesis	13b. TIME COVERED FROM _____ TO _____
14. DATE OF REPORT (Year, Month, Day) 1990 March	15. PAGE COUNT 197
16. SUPPLEMENTARY NOTATION	

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP			
12	04		Decision Making	GDSS	Logistics Need
15	05		Group Decision Making	MAUM	Delphi
			Decision Support Systems	MCDM	

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Anually, the Air Force Office for Logistics Technology Applications (AFOLTA) is responsible for developing a prioritized list of the Air Force Logistics Needs (LNs) to aid military and industry decision makers who allocate funds for logistics research and development programs. To develop this list, AFOLTA convenes a conference with representatives from the Air Force Major Commands who, as a group, prioritize the LNs. The decision task is characterized by its complexity, having a great amount of uncertainty, yet being extremely important to increasing Air Force operational capability.

This research focused on the decision process involved in prioritizing LNs and on the design of a group decision support system (GDSS) to aid the decision process. The requirements of such a GDSS were assessed. The functions, processes, models, and data required for prioritizing LNs were

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL John R. Valusek, LtCol, Asst Professor	22b. TELEPHONE (Include Area Code) (513) 255-3362
	22c. OFFICE SYMBOL ENS

DD Form 1473, JUN 86 Previous editions are obsolete SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

19. (cont)

identified and incorporated into the design of the GDSS.
The kernel design of the GDSS was a management information system to support the informational requirements of a multi-attribute decision making model.
A roadmap plan was prepared for transitioning from the current process to implementing the designed GDSS.